BELL TELEPHONE QUARTERLY

VOL. XVII JANUARY, 1938

THE "PLAN FOR EMPLOYEES' PENSIONS, DISABILITY BENEFITS AND DEATH BENEFITS" COMPLETES TWENTY-FIVE YEARS OF SERVICE

SOME FUNDAMENTALS IN STANDARDIZATION

ORGANIZING FOR SERVICE

SOME UNUSUAL TELEPHONE CONSTRUCTION PROBLEMS

THE COLLECTED PAPERS OF GEORGE ASHLEY CAMPBELL

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW Y

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

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VOL. XVII NO. 1

PUBLISHED QUARTERLY FOR THE BELL SYSTEM BY THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY. SUBSCRIPTION, $1.50 PER YEAR, IN UNITED STATES; SINGLE COPIES, 50 CENTS

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The "Plan for Employees' Pensions, Disability Benefits and Death Benefits" Completes Twenty-five Years of Service

A QUARTER century ago, on January 1, 1913, the Bell System Plan, to afford a substantial degree of assurance and assistance in economic exigencies associated with sickness, accident, death, and retirement, went into effect. This Plan is provided by the companies without any direct or indirect cost to employees. It was conceived and prepared to apply to all employees alike who meet reasonable eligibility requirements, by establishing benefit and pension payments on an equitable basis according to service and wage histories.

It is interesting to recall the point of view of the Plan's creators during the period of study that led to its adoption. These viewpoints, characteristically, had their genesis in the feeling of responsibility for the protection of the service. Those charged with the duty of investigation and recommendation regarding the Plan were considering a complex business that rendered an essential public service which by its very nature must be a continuing enterprise—a business that, for its adequate functioning, required a loyal organization having sustained vitality. To insure such an organization it was necessary to recognize and make reasonable provision for those hazards of life which interrupt earning capacity and bring about unexpected and sometimes heavy burdens. It was also necessary to meet the problem of aging of personnel through an appropriate retirement plan so that the vitality of management and organization could, at all times, be maintained and the expense, which would result from continuing in service those who become superannuated, be avoided.

In the consideration of these factors it was recognized that—

"It is but natural that every employee should desire to assume the normal responsibilities of life and to surround himself and those dependent upon him with the things that make life complete and enjoyable. Unforeseen happenings may make these responsibilities heavy burdens, and whatever may be put aside for the day of misfortune must, in the beginning, be small and accumulated slowly. A realization that obligations must be met in times of misfortune, as well as in times of prosperity, has made the need of something beside merely an old age pension appear absolutely vital.

"Employers buy and employees sell service. Perfect service is only to be found when fidelity and loyalty are reciprocal in employer and employee. It is this relationship that brings satisfaction and success to both.

"The intent and purpose of the employer in establishing a plan of benefits, is to give tangible expression to the reciprocity which means faithful and loyal service on the part of the employee, with protection from all the ordinary misfortunes to which he is liable; reciprocity which means mutual regard for one another's interest and welfare.

"This is justice, and without justice and sympathetic interest, we cannot hope to do a thoroughly good piece of work."

By those who are familiar with Bell System policies, the above quotation might be given a current date and be fully accepted as applying to the motive that exists today—"to do a thoroughly good piece of work." However, these excerpts are taken from the letter which Theodore N. Vail, then President of the American Telephone and Telegraph Company, sent to employees of the Bell System a quarter century ago in announcing the Plan for sickness, accident and death benefits and pensions which went into effect at that time. The importance of this far-sighted vision is emphasized when one considers that these steps were taken many years before such practices were generally recognized and, of course, long before the recent trends in social security, as now provided through legislation.

Twenty-five years' experience in this comprehensive and uniform program of employee benefits, designed to provide sub-

stantial protection to telephone employees against the economic hazards of life, has fully demonstrated the value to employees and the company of these humanitarian principles as applied to the efficient operation of the business. These results are especially pertinent to telephone service which involves the human element to such an unusual degree and which can only function satisfactorily through well-trained forces maintained at a high level of morale and efficiency. The Plan has aided materially in attaining this desirable end by providing for a sense of security to offset, to a reasonable extent, the fear and uncertainty regarding financial need which are ordinarily associated with superannuation, physical impairment, and death.

Previous Relief Measures and Development of Plan

Prior to the adoption of a System Plan, various relief measures were used to meet emergencies arising from disability and death. However, such practices as were followed were mostly informal arrangements which varied greatly between different companies and between departments of the same company. In all instances, the extent of relief was quite restricted and was based entirely on discretionary treatment by the companies in individual cases.

During the decade preceding the adoption of the Plan, careful study was made of the underlying conditions and the fundamental principles which should apply to a well-designed plan intended to meet, on a sound business and social basis, the needs of the telephone industry. It was believed that such a plan should apply uniformly to all employees who fulfill reasonable eligibility requirements by virtue of their employment and should not be considered or designed as a means for dispensing relief on a charitable basis. It was also necessary to provide for a uniform plan in all the Bell System Companies with an arrangement for interchanging benefit obligations so that employees might aspire to work anywhere in the System with uninterrupted benefit privileges and any company might obtain

any employee it needed without affecting his service record or other factors relating to eligibility that he had previously acquired. Accordingly the Plan, as adopted and as since amended from time to time, provides benefits and pensions on a unified basis in a reasonable degree to assist in meeting the ordinary hazards of life to which the respective payments apply.

The most essential element of any plan of this kind is its security and payments provided by the Plan should not exceed such amounts as are appropriate for the purposes intended or which might affect its continuing character. In view of these essential elements, the Bell System Plan does provide liberal and reasonable protection against the stated vicissitudes of life, which interrupt or terminate earning capacity, on a basis which is advantageous to the employee, consistent with sound business principles and in accord with social thought.

General Description of Plan and Its Administration

Briefly, in the "Plan for Employees' Pensions, Disability Benefits and Death Benefits" the Bell System Companies undertake to provide for the payment of definite amounts to employees when they are disabled by accident or sickness or when they are retired from the service because of such disability, or in the event of death, to their dependents. As previously stated, the full cost of these benefits is met by the company, no contributions being required from employees. All payments under the Plan, except service pensions, are charged to current operating expenses when and as paid. As will be explained later, service pensions are paid from Trust Funds built up on an actuarial basis by annual accruals and these Funds are dedicated solely to the payment of such pensions. The Plan is administered in each company by an Employees' Benefit Committee composed of five members appointed by the Board of Directors. All of the major departments in the respective companies are usually represented on these Committees and close administrative contacts are maintained between Benefit Com-

mittee organizations and the various department organizations to insure thorough consideration and understanding of each case, individually.

The Employees' Benefit Committee of the American Company, in addition to administering the Plan for that Company, acts in an advisory capacity to the other companies which have adopted the Plan by way of making interpretations and recommending methods and practices which make for consistency among these various companies. In addition, the centralized preparation of statistical and other pertinent information and the frequent interchange of opinions and suggestions insure a degree of uniformity in the equitable administration of the Plan which could not otherwise be attained so comprehensively and completely.

In order to achieve a degree of flexibility essential to the fair treatment of individual cases, limited discretionary authorities are vested in the Benefit Committee under the provisions of the Plan and certain additional authorities are granted the Committee for making supplementary or special payments outside the Plan in exceptional cases of long duration or in cases involving unusual circumstances which cannot be covered by a uniform schedule. However, these discretionary powers of the Committee do not include the right to modify the Plan, except with the consent of the President and the approval of the Board of Directors and, even under these conditions, such changes shall not affect the rights of any employee, without his consent, to any benefit or pension to which he may have previously become entitled under the Plan as in effect prior to such change.

A more complete description of the general classes of benefits provided by the Plan and experience in connection with the administration of these payments during the past twenty-five years seems necessary in order to obtain a comprehensive understanding of the interrelated features of the Plan. As previously indicated, these general features cover sickness dis-

ability benefits, accident disability benefits, death benefits, and pensions.

Sickness Disability Benefits and Disability Pensions

In the event of disability resulting from sickness or accidents occurring outside of employment, benefits are payable to all employees who have completed two or more years of service. These payments, which start after a waiting period of seven days, range from four weeks' full pay and nine weeks' half pay for employees who have completed two years of service, to thirteen weeks' full pay and thirty-nine weeks' half pay after ten years of service. Experience shows that about 83 per cent of the cases occurring are completed during the full-pay periods and that only about 3 per cent of the cases extend beyond the half-pay periods provided by the schedule. Since the Plan went into effect, approximately $89,770,000 have been paid to employees under its provisions because of sickness disability. In addition, there has been disbursed about $11,500,000 for supplementary need in exceptional cases requiring special assistance, and $31,690,000 charged to departmental accounts for other sickness payments outside the Plan. These amounts, and others hereinafter mentioned, are for all Bell Companies which have adopted the System Plan and interchange benefit obligations, including the Western Electric Company and Bell Telephone Laboratories.

Employees who become totally and permanently disabled after having completed fifteen years of Bell System service are eligible, under the discretionary provisions of the Plan, to receive disability pensions. These disability pensions are designed to provide financial assistance, as based on need, in cases which extend beyond the sickness disability period of fifty-two weeks provided in the Plan, where the disability appears to be of a continuing character. At the present time, there are about 1000 former employees retired on disability pensions and, since

the Plan was adopted, the total payments for this class of pensions have amounted to about $3,170,000.

Accident Disability Benefits

At the time the Plan was made effective, there were only a few states which had enacted Workmen's Compensation Laws. The Bell Companies, however, felt the need of making benefit provisions for cases of accidents arising out of and in the course of employment, and, accordingly, these benefits were included in the Plan. In other words, the equitable principle underlying the compensation legislation has been recognized by the Bell System since the Plan began. Although there are variations in different state compensation laws, the inclusion of accident benfits within the formal Benefit Plan makes this element of protection uniform throughout the System.

In cases of total disability, full pay is authorized during the first thirteen weeks and half pay for any period of total disability after the first thirteen weeks, provided that, after expiration of six years of disability payments, the benefits shall not exceed $20 per week. In cases of partial disability, 100 per cent of the difference between full pay at the time of injury and wages which, in the judgment of the Benefit Committee, the employee is capable of earning, is authorized during the first thirteen weeks. Subsequent to the first thirteen weeks, 50 per cent of such difference is paid for a total period of disability payments not to exceed six years. In all, except relatively few cases, these payments are greater than provided for under the compensation laws of the various states and where payments under the Plan are greater than those provided by law, the excess is paid under the Plan. During the last twenty-five years, approximately $18,550,000 have been disbursed in accordance with the provisions of the Plan in accident disability cases.

Death Benefits

In death cases of employees resulting from accidents in the course of employment, the maximum death benefit is an amount equal to three years' pay but not to exceed $5,000 or the benefit which would have become payable if the employee had died from sickness, whichever amount is greater. In addition, the Plan provides, in these cases, for the payment of certain burial expenses. In the event of death from sickness or death from accidents occurring outside of employment, benefits are payable to certain defined beneficiaries of employees whose term of employment amounts to two years or more. The maximum payments under these provisions start at four months' pay in the case of employees having two but less than three years of service, and increase by one month's pay for each additional year of service until they reach a maximum benefit amounting to twelve months' pay in the cases of employees having ten or more years of service.

Payments may also be made at the discretion of the company to the dependent beneficiaries of employees retired on pension up to the maximum amount which could have been paid under the Plan as a sickness death benefit if the employee had died on his last day of active service. Certain beneficiaries of employees who die before retirement, as, for instance, a wife living with her husband at the time of his death, and children supported by the employee, who are less than eighteen years of age, qualify for these payments under the Plan regardless of actual dependency. In other cases, eligibility is contingent upon actual dependency and the facts as to this condition are determined by the Benefit Committee.

The purpose of the death benefit is primarily to provide a continuation of income, for a limited period, to assist the dependent relatives of deceased employees in their readjustment to new economic conditions resulting from the termination of the wages or pension. Since the Plan has been in operation,

approximately $21,510,000 have been disbursed in death cases of active and retired employees.

Service Pensions

(*a*) *Purposes*

The remaining general class of payments provided for under the Plan is service pensions. Pensions are of particular importance to those employees who have long service with the System and the general subject is, of course, especially significant because of the current popular interest in this form of security. The provisions for service pensions in the Plan have been developed with due consideration of the other features of the Plan described previously. Aside from its commendable social purpose, the sound business reason for the retirement plan of the Bell System is to further the efficient and economic operation of the business by meeting effectively the problems arising from the aging of the personnel.

The Plan makes possible, after reasonably long terms of service, the retirement of individual employees and the general retirement of all who have reached an advanced age, whether superannuated or not, for the purpose of vitalizing the organization as a whole. The Bell System must retain, in competition with other employers, personnel qualified for the effective operation of its business and, as previously mentioned, must, at all times, maintain a high morale among its people. From a sound business viewpoint, the retirement plan is a definite and important feature in retaining desirable qualified personnel and in maintaining the required morale. The advantages of pension provisions from the employee's personal viewpoint are, of course, quite obvious.

(*b*) *Eligibility Requirements*

To become entitled to a service pension, an employee must have completed a specified term of employment and, for certain

classes of pension, have attained a specified age. The expression "term of employment," as provided for in the Plan, means a period of continuous service credited in the company, or in the company and one or more Associated or Allied Companies with which reciprocal agreements have been made for the interchange of benefit obligations. Any absence from the service, without pay, other than absence during a period of disability benefits or leaves of absence or temporary lay-off, as defined in the Plan, constitutes a break in the continuity of service unless the Board of Directors authorizes the Committee to consider such absence as a leave of absence. A rule, approved by the Board of Directors, has been adopted, however, under which breaks in the continuity of employment are "bridged" after an employee has completed ten years of continuous reemployment. In cases where the absence has not exceeded six months, or in breaks in service due to attendance at schools, the Committee is authorized, in its discretion to bridge such breaks prior to the completion of ten years of reemployment.

Retirement on service pension is provided for employees coming under the following classifications:

Class "A"—Employees whose age is 60 years or more (females 55 or more) and whose term of employment has been 20 years or more.

Class "B"—Employees whose age is 55 to 59 years (females 50 to 54) and whose term of employment has been 25 years or more.

Class "C"—Employees whose age is less than 55 years (females less than 50) and whose term of employment has been 30 years or more.

Employees in Class "A" may be retired with a service pension at their own request or at the discretion of the Committee. Employees in Classes "B" and "C," while not eligible to be retired at their own request, may be retired with service pension at the discretion of the Committee and with the approval

of the President or a designated Vice President of the company. An employee becoming sixty-five years of age, is retired at the end of the month in which that age is reached. Service pensions, as provided by the Plan, are, of course, granted to those persons so retired who are eligible to such pensions.

(*c*) *Computation of Pension*

The Plan provides that the annual service pension shall be one per cent for each year of service, multiplied by the average annual pay during the ten years preceding retirement, provided, however, that the Committee may, at its discretion, base the pension upon the average annual pay for the ten consecutive years during which the employee was paid the highest rate of wages. The minimum service pension for full-time service is thirty dollars per month. Pensions computed on the basis of average service during the ten years preceding retirement are generally larger and bear a closer relation to salary and living expenses at time of retirement than would result from basing the pension on average pay during the entire period of service.

Under its terms, pensions payable under the laws of any state or country shall be deducted from pensions otherwise payable under the Plan. The Bell System Companies, in 1936, advised their employees as follows in respect to this provision of the Plan:

> "No change is contemplated in the Plan on account of the Federal Social Security Act of 1935 except that if the Act shall remain in effect unchanged until 1942, when payment of Government Pensions begins under the Act, it is expected that the provision now in the Plan that all of the pension paid by the Government shall be deducted from pension otherwise payable under the Plan will be changed to provide that only one-half the pension paid by the Government under the Act shall be deducted. In other words, if the Act remains unchanged, the employee retiring on pension after 1941 will receive from the Government and the Company together the equivalent of his or her full pension from the Company plus one-half of the Government pension, which

half represents, in effect, what the employee has contributed toward the Government pension through the tax on his or her salary or wages."

(*d*) *Pension Trust Funds and Disbursements*

From 1913 through 1926, service pensions, granted under the Plan, were financed on a cash disbursement basis. Where pensions, like other classes of benefit payments, were made from "Benefit Funds" established by the respective companies, amounts necessary each year to restore these Funds were charged to operating expenses. In 1927, the Bell Companies established separate Trust Funds under the Plan, from which all service pensions are now paid. The balances in the "Benefit Funds," aggregating $48,940,333, were transferred to the Pension Funds, and, since then, all benefits, other than service pension disbursements, have been charged directly to current operating expenses, when and as made.

The companies have undertaken to maintain their respective Pension Trust Funds in such amount that when employees become eligible under the Plan to receive service pensions, there will be available in the Pension Funds amounts sufficient to provide for their pensions according to the terms of the Benefit Plan. For the purpose of meeting these obligations and, at the same time, to effect a more even distribution of the cost of pensions over the years with the advantage of interest earnings on amounts funded, the companies adopted, in 1927, an accrual program based on the principle of accruing currently, as charges to operating expenses, amounts which, according to actuarial computations, are designed to make appropriate advance provisions for future pension disbursements.

As provided in the Trust Agreements, the Trustee is required to hold the Pension Funds solely for the payment, as directed by the companies, of service pensions granted by them under the Plan. In cases of termination of the Plan, or in case of revocation or other termination of any Trust Agreement for

service pension purposes executed under the Plan, the company, as set forth in the Plan, undertakes to preserve the integrity of the Pension Fund as a Trust Fund to be applied solely to service pension purposes and to take such action as may be necessary or appropriate to insure the application of the entire Pension Fund to service pension purposes. Therefore, the amounts trusteed in the Pension Fund are irrevocably devoted to service pension purposes and no part there of constitutes an asset of the company or can become such an asset in case of termination of the Plan, or termination or revocation of the related Trust Agreement.

Since the adoption of the Plan, about $40,300,000 have been disbursed by the companies for service pensions, and, at the present time, there are about 7,800 retired employees receiving these pensions. After deducting pension disbursements, there is now set aside an aggregate amount of about $223,000,000 in the Trust Funds of the respective companies. The accruals, which are being paid currently to the Trustee to provide for future pensions, amount to approximately $16,000,000 annually. As previously indicated, these figures include amounts for the Western Electric Company and Bell Telephone Laboratories.

Employee and Company Responsibilities

In evaluating security measures of this general nature, it is important to understand that amounts which can properly be disbursed for such protection must necessarily cover large groups on a uniform basis, taking into account wage and service history. Beyond this general coverage the individual should endeavor to provide for himself and dependents according to the circumstances which apply to his particular requirements. Such provisions, which are a responsibility of each individual, may supplement the protection provided by the Plan or may, of course, be amounts which are desirable for other economic purposes of particular interest to the respective employees.

In any event, complete security which is desired to meet all economic conditions becomes a joint undertaking. After the company has made reasonable provisions for the ordinary hazards of life, so far as can be justified by the dictates of sound business judgment, the employee should maintain his individual initiative and responsibility to supplement this protection for the future according to his particular needs. This fundamental principle is as important to the employee in maintaining his individuality as it is to the company in maintaining, on a secure basis, the protection which it provides.

In looking back over the years, one can only be impressed with the enormous good to the employees and the company which has resulted from the Plan. It is to the mutual advantage of both that this important undertaking be carefully safeguarded for the future. This responsibility on the part of both employees and the company involves a broad and comprehensive understanding of the intent and purpose of the Plan and the exercise of good judgment, in order to avoid measures which might affect its security.

CHARLES J. SCHAEFER, JR.

Some Fundamentals in Standardization

(Editor's Note: This is a section of an address given December 1, 1937, before the American Standards Association, by Mr. Frank B. Jewett, Vice President of the American Telephone and Telegraph Company.)

THIS Association, which is the direct lineal descendant of the first engineering society standards committees, has come gradually into a position of great power and grave responsibility—greater and graver even than most of us appreciate, I suspect. Not only does your imprimatur influence directly the things of industry with which you are concerned and the affairs of their users, but in many directions it becomes part of the base of statutory regulations, ordinances or laws. It is from this angle that much of your enhanced responsibility for careful, thoughtful and meticulous functioning arises.

The formal ordinances or laws of the State are hardy "beasties," difficult to change and almost impossible of extermination. They spawn argument, conflict and litigation at a prodigious rate and of a kind that gladdens the heart of those who like to fish in muddy water. Since much of this water is now of your making, it behooves us to look well to its quality and filtration before turning it into the public distribution system.

Outside what I have observed of standardization in other fields of applied science, substantially all my ideas concerning it, concerning its possibilities and limitations, concerning the objectives for which it is undertaken, and particularly concerning the basic rules which, it seems to me, should govern approach to the formulation of any standard, have been derived from the experience of nearly thirty-five years devoted to the orderly development of electrical communication. Throughout this entire period, standards and standardization have been looked upon as powerful tools for progress in the communica-

tion art. Occasionally, but not often in recent years, they have turned out to be serious obstacles to it.

Having determined many years ago to make the development of telephony and its collateral forms of electrical communication in the Bell System as far as possible an orderly process based on established principles of science and engineering, it was inevitable that standards and standardization should early come in for careful analysis. Because of the peculiarly favorable conditions for unity of operation present in the structural set-up of the Bell System—research, development, manufacturing, installation and operation being all under a common direction, and with all parts of the organization concerned with a common objective—our experience might be considered in the nature of a trial installation of standardization under ideally controlled conditions.

While all of us have subscribed to the common objective of the best and most extensive telephone service which science and art can provide at the lowest cost consistent with financial safety, I would not have you think we have been free from violent differences of opinions in the matter of standards to be adopted or altered. In so far as matters relating to standards were wholly of internal concern, the one thing we have been spared was the conflict of divergent views based on real or assumed differences of objective.

Since the only thing we sell to the public is service, we have in the main been free from the ordinary manufacturer-customer conflict of requirements in our standardization of the material things required for giving that service. To a considerable extent it is immaterial to us which of two things we decide to standardize, provided only that the one chosen, when related to all the other factors which make up final overall cost will give the best life service at the lowest cost. Thus, for example, as between two designs giving equally good operational results, we have no hesitancy in standardizing the one of higher initial cost if it is clear that by so doing we will save

much more than the difference on reduced maintenance expense over its useful life.

Early Conclusions Strengthened

My first study of standardization and the function and place of standards led me to certain conclusions, most of which have been strengthened by subsequent experience.

In the first place, it seemed clear that when the telephone art had progressed far enough in any sector to make true standardization feasible, the establishment of standards and rigid adherence to them until they were superseded by better standards was the only certain way to ensure orderly and expeditious progress.

In the second place, it seemed clear that the standards set should take account of *all* the pertinent factors and should so far as possible omit *all* non-essential requirements; in a word, that they should make mandatory only those things clearly necessary in the attainment of a desired result and should leave maximum freedom for variation in all else.

In the third place, it appeared that standards should never be allowed to take on the habiliments of things sacrosanct but should be under continuous critical surveillance; that they should be discarded or modified promptly whenever it was clear that they had ceased to be tools of progress and become hindrances to it instead.

Standards Short-lived

As a result of these and numerous other fundamental considerations which will occur to all of you, standards as we employ them in the Bell System are frequently short-lived affairs. We respect and value them for the help they give us while they live. We refuse to let them dominate our thinking and we discard them without a qualm when they become shackles. I think our attitude toward them might be expressed by saying

that, in our picture, today's standards are today's statement of the most we know about the things we employ. Tomorrow's standards may or may not be the same. One thing we do do when discarding an old friend is to be sure that the new one will serve us better and, so far as possible, to have a definite bridge between the old and the new.

Another thing we learned early in our work was that a nice question was involved in determining just when to attempt standardization. If it was attempted too early in the development of a new thing or a new method, we ran not only risk of wholesale use of something inferior to the best attainable, but to a considerable extent we shackled and straight-jacketed development. If standardization was too long deferred, development and use tended to run riot and produce a situation akin to one in which there were no standards or guide-posts to serve as definite points of departure.

On the whole I am inclined to think that the first, *i.e.*, a too early standardization, involves the greater hazard. It is a serious thing to stimulate the use of an inferior thing or method by designating it as a standard. It is a far more serious thing to shackle and delay development by so doing.

The establishment and promulgation of engineering or industrial standards always has a powerful influence on men's thinking and acting. There is universally a tendency to think and work *toward* a standard—seldom away from it, unless those concerned with the thing standardized appreciate fully that the standard is simply a transitory affair. Men will invariably spend more energy and thought in the direction of achieving the standard than they will on breaking new ground beyond it. They have a tendency to exercise their energy and inventiveness largely in devising cheaper ways of attaining standard results.

Where the established standard is distinctly above the average of the things to which it applies, this magnet-like tendency has its advantages since it stimulates those who are in the in-

ferior position to seek a higher level, and, since they are in such case a majority, it acts to raise the general level even when it retards somewhat those who have been most progressive.

With premature standardization also, all the forces involved are marshalled largely behind the status quo. Custom, established methods, money invested in tools or plant—all argue against change. It is so upsetting!! On the other hand, where proper standardization has been delayed beyond the time when it should have been done, the very turmoil and chaos of the resulting situation almost automatically impels conflicting interests to seek a common meeting ground. Further, from the welter of confused experience there is much material that can be salvaged in the making of a standard.

Trial Period Needed

Although I realize the difficulties inherent in the process, it has always seemed to me that the tool of "trial installation" could in many cases be a valuable addition to the machinery of standardization. Possibly in my ignorance of modern standard-making methods, I am advocating something which is already in effect. All that I have in mind is a field trial of the thing proposed on a sufficiently large scale and under sufficiently complete observational control to test thoroughly all the factors involved without committing everybody in advance to the new proposal. In a way the "tentative standard," or whatever you designate it, is along the lines I have in mind, although, as I have observed its operation in some cases, it seems to fall short of what I have in mind. It invites and depends too much on uncontrolled and uncoordinated observation, and so retards final decision and leaves that decision largely involved in a compromise of opinions.

In the Bell System where, as stated earlier, research and development, manufacturing, engineering, installation and use are all looked upon merely as parts of a common problem, and where standardization is undertaken solely to insure the best

that the current art affords and to facilitate improvement in the elements involved in rendering service, the controlled field trial has long been an established routine. No new thing of any importance is ever put into general use without it. Primarily designed to bring to light defects or improvements which have either been overlooked in the laboratory or which from their nature can only be determined in the field, it serves almost automatically to determine the requirements of new standards which can and should be established for use until they in turn are supplanted by still better ones. It is, in fact, the use of "industrial guinea pigs." While it does frequently involve experimentation on the ultimate consumer, it is only on a limited group of consumers, so that adverse reactions can never reach major proportions.

When it comes to how standards should be made and who should participate in their formulation, it has always seemed to me that machinery like that of the American Standards Association or some body similar to it is the only sensible kind to employ, except possibly in those fields involving matters of such vital importance to the general population that only political Government has the power to cope with them.

Even here, however, it is hard to see how an organization such as the American Standards Association can fail to be of the utmost assistance. The technical and scientific world has become so complex, and controlling factors in almost every sector are found in such unexpected places, that only by having a forum where every one who has a right to be heard can be heard, are we assured of that final judgment which will command adherence and respect.

Compromise Necessary

Furthermore, it is only from such a voluntary association that we can expect to have that degree of compromise without which no industrial standard, however perfect and desirable

it may appear to its makers, can hope to succeed. I have observed that it is the exception rather than the rule when men are reasonably unanimous in acting like rational human beings. Ordinarily we are a perverse lot who greatly dislike being told what we must or must not do even when we know that the prescription is clearly in our interest. If, however, we feel we have had our day in court we are usually ready to give the verdict a fair trial, including a peaceful appeal, when necessary, to the court if we are still dissatisfied.

It is when we feel that our interests have been grossly outraged or our evidence slighted and passed over in the final decision that we put on our guerilla togs and go out on a foray. All of this is just as true in the field of standardization as it is in any other area of human activity. Any standard which is made and promulgated in opposition to the fixed opinions, however acquired, of any considerable group involved in its operation, is foredoomed to hard sledding and almost certainly to failure. Such a group would be more than human if they did not seek to make it fail.

It was considerations such as these which long ago led me to feel that to be successful in the field of standardization, the body responsible for a work which has become increasingly important to industry and commerce and to society generally, should have certain characteristics. It should be a voluntary association with the broadest possible constituency in the field of its interest; its operations should be democratic with all that that implies of much essentially futile discussion and apparent procrastination; it should let facts, so far as they can be obtained, rather than opinions determine the answer; finally, the Association itself should not be clothed with any police powers of enforcing its own findings—it should depend on the proven validity of its conclusions and the recognized standing of its members if it would insure general acceptance of its work.

The Importance of Facts

Apropos of these two last points, I should like to remark that they but paraphrase observations made to me many years ago by two wise men, now dead, who were my friends—General J. J. Carty and Mr. Elihu Root. Early in my career as one of his assistants, General Carty impressed on me the importance of getting facts before forming opinions or drawing conclusions if one wished to obtain a valid and acceptable answer. It was his belief and one he operated on consistently, that the answer to almost any question was 90 per cent automatically self-evident if one took the trouble to assemble and scrutinize the known or ascertainable facts which bore on it. Anyone who was ever involved with him in consideration of some knotty problem will never forget the interminable hours, days, and even weeks or months which he devoted to fact finding. It was soul-trying and patience-trying and it led into most unexpected places and to most unexpected individuals but it got results that were rarely wrong.

Long ago Mr. Root pointed out to me the inherent fragility of action based primarily on legal authority and the almost irresistible power which inhered in the judgment of a body of men possessed of no power to enforce that judgment but who were recognized to be men of ability and character and who formed their opinions with studied deliberation.

My distrusts of Government as a maker of standards that affect commerce and industry, i.e., outside those sectors of public health or safety or national defense where Government alone can act, are more basic than fear of intrusion of political factors. They reside (1) in the belief that the agencies of Government, circumscribed as they are of necessity by the restraints of Government, are not in the best position to obtain and appraise all the facts; and (2) that being agencies of Government, anything they emit tends to appear more important than it really is and more difficult to abandon or modify.

Government Should Participate

In other words, standards made by Government are, it seems to me, more likely to become instruments of restraint to progress than are those emanating from a mobile body like the American Standards Association. When to this is added the almost inevitable tendency that develops in men clothed with apparent authority, to exercise it punitively, it seems to me that the case for the voluntary association in the field of standardization is substantially iron-clad.

Nothing of what I have just said should be construed as a belief on my part that Government should be excluded from participation in the making of standards—quite the contrary. Government should participate largely but, I think, on the same voluntary basis as the other members of the association. Added to its general concern in establishing standards wherever these are clearly in the public interest, Government in times of peace is itself a large consumer and so entitled to be heard. In times of war it is the largest consumer. Anything in the direction of wise standard making in times of peace which will facilitate the functioning of Government and industry in time of war is obviously in the common interest.

I know that all the foregoing is "old stuff" to you and I am not saying it with any thought that it need be said here where all agencies—Governmental and non-Governmental—meet together. What I really had in mind in saying what I have is that possibly my opinion based on long experience may add a pebble to the dyke which periodically has to be raised against a demand that Uncle Sam take on part or all of this standardizing job because he can do it so much better or so much faster. It is usually a plausible tale that is told and it has only one demerit—it is not true.

In concluding I do not know that I can do better than attempt in brief summary to restate my own picture of what proper industrial standards should be, how and by whom they

can best be formulated, and some of the things which appear to me we should guard against in their use.

The Life of Industrial Standards

Before doing this I should like, however, to emphasize two things which, while interrelated, are frequently badly confused particularly by the non-technical public. First, industrial standards are essentially different from the so-called "absolute" standards of science—such, for example, as the unit of time. These "absolute" standards if accurately determined and readily reproducible are "absolute" in a very real sense—they are ordinarily not subject to change with advancing knowledge. They are the scale by which we measure it.

Industrial standards on the other hand are akin to the hypotheses of the scientist. They define our present state of knowledge and they live only so long as they continue to define adequately. As soon as they fail so to define, they are for all practical purposes as dead as the ancient Dodo or the Great Auk and like them are of interest only in a museum.

To the non-technical this difference is not generally understood and from the misunderstanding arises much difficulty. To them "standard" has come to denote something fixed, final and generally desirable. They instinctively resent anything which seems to cast doubt on its paternity and they impute base motives to all who advocate change despite the fact that changing industrial standards are the very hallmark of industrial progress.

Now for my summary picture.

To me a proper engineering or industrial standard is a temporary statement which includes all that is really essential of proven current knowledge needed to define the thing standardized. It is a specification which can be met in current commercial practice and a tool by which the art can progress. It carefully excludes everything which is non-essential in order to insure maximum latitude alike to the developer and user. In

a word, it is a common meeting place for purchaser and seller, with no signs of *caveat emptor* about.

It is continually under scrutiny by all who have occasion to use it and is subject to ruthless modification or abandonment as soon as it has clearly ceased to function as intended.

It is created by a voluntary association of all groups who have a definite interest in its existence and by representatives of them chosen because of established reputation for competence and ability to weigh evidence, honestly and impartially. The standardizing body itself should be without legal power to enforce its conclusions but like the Supreme Court should depend on the recognized merit of its findings. Where reasonable doubt exists as to the necessity for standards, the Association should err on the side of too few rather than too many.

Where it is known or believed that the standard sought to be established is likely to become adopted into ordinances or laws and so subject to administration by men who have legal authority of enforcement, the obligation on the Association to be meticulous in its final decision is greatly enhanced. Merely to clothe a standard with the habiliments of ordinance or law is to lessen materially our ability to change promptly in the face of changing conditions. With increasing prestige of the American Standards Association there will inevitably be increasing tendency to enact laws based on its authority.

FRANK B. JEWETT

Organizing for Service

IT is generally admitted by those who have had the opportunity for comparison that the United States, with one-half of all the telephones on the globe, has the best telephone service in the world. Not only is the service nationwide in scope, interlinking some 70,000 communities, but there is outstanding excellence in the qualities of the circuits which make for distinctness of the speech transmitted, in the speed with which connections are established, and in the cooperative attitude of the operating forces in their efforts to serve the public.

It is obvious that such a service could not just happen but on the contrary must be the result of many coordinated factors. An underlying reason, however, can be found in what is meant by the single word "organization," which is usually called the characteristic basis of American efficiency.

It is through Bell System organization that it is possible to express and crystallize the accomplishments of scientific research in a constantly changing art, the advances in engineering and operating technique, and the ideals and standards of management. It is because of organization that thousands of scattered groups are capable of immediate mobilization, are responsive to every change wrought by progress, are inspired with a glowing sense of responsibility. Without adequate organization, the human machine that gives the telephone life in the United States could neither adequately understand nor efficiently accomplish its giant task of public service.

As is well known, there is in the Bell Telephone System an integrated organization that functions under federal and state regulation to provide the framework that permits a unified and economical service. Because of this corporate organization the advantages of centralized research, centralized study in the fields of engineering, operating and accounting

practice, centralized consideration of personnel problems and centralized manufacture of standardized equipment all flow automatically to the operating units that have the responsibility of knowing and serving the communication needs of their communities.

But this corporate organization does not alone explain the efficient performance of the Bell System's 325,000 men and women as they concentrate on their individual tasks while united in a common vision and objective. Without a carefully planned and properly directed operating organization, there would be no practical way of coordinating the multitude of operations that combine to form "telephone service" as this is known and accepted in our country to-day. It would seem that the creation of such an operating organization constituted the most fundamental of management's problems, and that its existence to-day is in reality among the greatest of management's accomplishments.

The Purpose of Organization

What should determine the form and structure of an operating organization? It should be obvious that the controlling factor is, in the last analysis, *the work which has to be done.* In other words, organization should be thought of as a means to an end, not as an end in itself. The form of organization necessary to do a given job will vary, of course, with the nature of the work to be done, and the arrangement which will produce best results can only be determined by experience. It is one of the most important functions of management to make this determination and to modify the organization from time to time to meet changing conditions.

Careful consideration must be given to the ways in which the different elements of the work are grouped together into working units and to the relation of the number of supervisory people to the total force. This latter relationship, commonly

called "overhead," is often misunderstood, the popular assumption being that a low per cent overhead represents an efficient management and a high per cent overhead an inefficient management. If this were true the ideal would be no overhead at all. The result would be an untrained, undisciplined and undirected group of people and it would be absurd and contrary to all experience to expect such a group to produce best results. It follows that there must be some overhead even on the simplest work, the amount of course being dependent on the kind of work to be done. Obviously, the proper amount is that which will get the job done best with the least total cost and this can be determined only by experience. For example, a company with operating costs of $100,000 of which $10,000 or 10% was for overhead organization might find that by spending an additional $10,000 for overhead it could do the job as well or better and reduce its total costs to $80,000. Obviously, it would be good management to provide the larger supervisory organization, even though it resulted in increasing the per cent overhead from 10% to 25%. This indicates the value of careful consideration to overall results in determining for a given kind of work the proper amount of supervision to be provided.

As an example of the way in which organization is set up as a means to an end, let us consider one of the oldest and most familiar types of organization—that of the army. Here we have a large collection of men brought together for the purpose of protecting a country from attack by enemies. We all know that the primary requirement for repulsing an armed attack by an enemy is men placed on the firing line with guns and other military equipment. In a force of, say, 20,000 men, the large majority will be fighters on the firing line. Why should not all the 20,000 be fighters actually on the firing line? Simply because experience has shown that this force can be most effective in repulsing the enemy when divided up into units, each under the direction of a competent leader with ade-

quate provision for training and equipping the men. It is an established military fact that a well organized army of trained soldiers is more effective than many times its number of unorganized, untrained people.

As a result of this experience, we have the fighting men of an army grouped into squads, each under the direction of a Corporal. The squads are grouped into platoons, under the direction of a Lieutenant. Platoons are further grouped to form a company, under the leadership of a Captain. The requirements for training the men and carrying on certain clerical and routine business of the company is cared for by the appointment of Sergeants, of which there are from four to eight per company. Experience has further shown that the activity of these company units can be directed most effectively in the field by grouping them into battalions, under the direction and leadership of a Major or Lieutenant-Colonel. Battalions are, in turn, grouped into regiments under Colonels; a group of regiments constitutes a brigade under a Brigadier-General, and brigades are grouped into divisions under a Major-General. Several divisions constitute an army corps, and a collection of army corps constitutes the entire army, under the leadership of the Commanding General.

Now each of these leaders of companies, battalions, regiments, divisions, etc., must have assistants to help him in the effective discharge of his responsibilities, and staffs are provided for this purpose, the size of which is determined by the needs as developed through experience. It is the staff's responsibility to care for the planning and arrangements necessary to see that the fighting forces are adequately provided with food, clothing, shelter, guns, ammunition, transportation, communication, etc., which are necessary to their proper functioning. These leaders and staffs also study the plan of battle and develop the strategy and tactics which will make the fighting forces most effective.

The man on the firing line is impotent unless he is adequately armed and properly trained, and he needs effective direction and inspiring leadership. Obviously, the organization necessary behind the lines to do these things is just as important a factor in repulsing the enemy as are the men on the firing line. In an Infantry Division of about 20,000 men, roughly 75 per cent are privates, 20 per cent non-commissioned officers and 5 per cent commissioned officers, both line and staff. This relationship is the result of centuries of experience on the part of military authorities in handling troops, and it would be unsound to conclude that this overhead of 25 per cent is wrong because industry conducts its operations with more or with less overhead organization.

The Telephone Army

The organization just described finds something of a parallel in the Bell System. Here we have a group of people enlisted for public service in providing an adequate, dependable telephone service. On "the firing line" we have the business office representatives who take the subscriber's orders for service and transact the Company's business; the installers and repairmen who connect the customers with the System and keep their lines in good order; the operators who work the switchboards to meet the subscriber's demands for telephone connections; the maintenance men who keep the plant in working condition; the accounting clerks who prepare the subscriber's bills, etc.

Just as "the firing line" forces of the army need corporals, sergeants, lieutenants, captains, colonels, etc., these telephone line forces need supervisors, chief operators, foremen, district managers, division managers, etc. Also, as the army needs staff people at various levels to keep the men on the firing line properly armed and trained, so the telephone operation requires groups of staff people to provide the line forces with the things they need to perform their functions—i.e., switchboards, wires, buildings, adequate training, methods for doing

their work, etc. These supervisory people, directing heads, and staff assistants are essential factors in meeting the objective of the telephone operation which is to provide the best possible service at the lowest practicable cost. The number of these people and the nature of the groups into which they are organized are the result of management's experience in getting the job done.

Let us examine this matter in somewhat more detail by analyzing the situation in one of the major departments of the business, i.e., the Traffic Department. Primarily, this work involves establishing telephone connections at the switchboards, and the bulk of the personnel consists of carefully trained young women stationed at the switchboards to answer calls and complete connections. There are about 135,000 employees in the Traffic Departments, of which roughly 105,000 are the operators at the switchboards.

Now, we could, of course, put the entire 135,000 at the switchboards, just as in the army example we could have had the entire 20,000 men equipped with guns on the firing line, but experience shows that this is not the right way to get the best job done. It has been ascertained, by carefully conducted trials, that a given number of people in the central office will produce better overall results when one or more of them is assigned as supervisor to assist the operators at the switchboard than when all sit at the switchboard and establish connections without supervision. The supervisor's job is to oversee the work going on in her group, to take care of the special cases which arise calling for treatment beyond what the operator is in a position to provide, and to coach and train continuously the members of her group. The number of such supervisors required in any office is largely dependent upon the number and experience of the operating employees.

Each group of operators and supervisors constituting a central office must, in turn, be under the direction of a responsible head, and this person is known as the Chief Operator. In the

administration of her work, the Chief Operator needs assistance in planning force schedules, carrying out details of force assignment, keeping office records, etc., and, therefore, clerks are provided for this purpose.

Several central offices taken together are grouped into a district under the direction of a man known as District Traffic Manager. He is responsible for the quality of the service in these central offices, for seeing that the work is carried on at the lowest practical cost, and that interest, enthusiasm and loyalty is maintained among the operating forces. His activities include such things as attention to the adequacy and arrangement of central office facilities, adequate provision of operating and supervisory employees and their proper training and development. To help him he may require staff assistants in caring for the many administrative problems involved. The number of assistants varies as between districts, dependent upon such factors as the number of central offices in the district, the number of employees involved and the amount of detailed administration carried on at the district level.

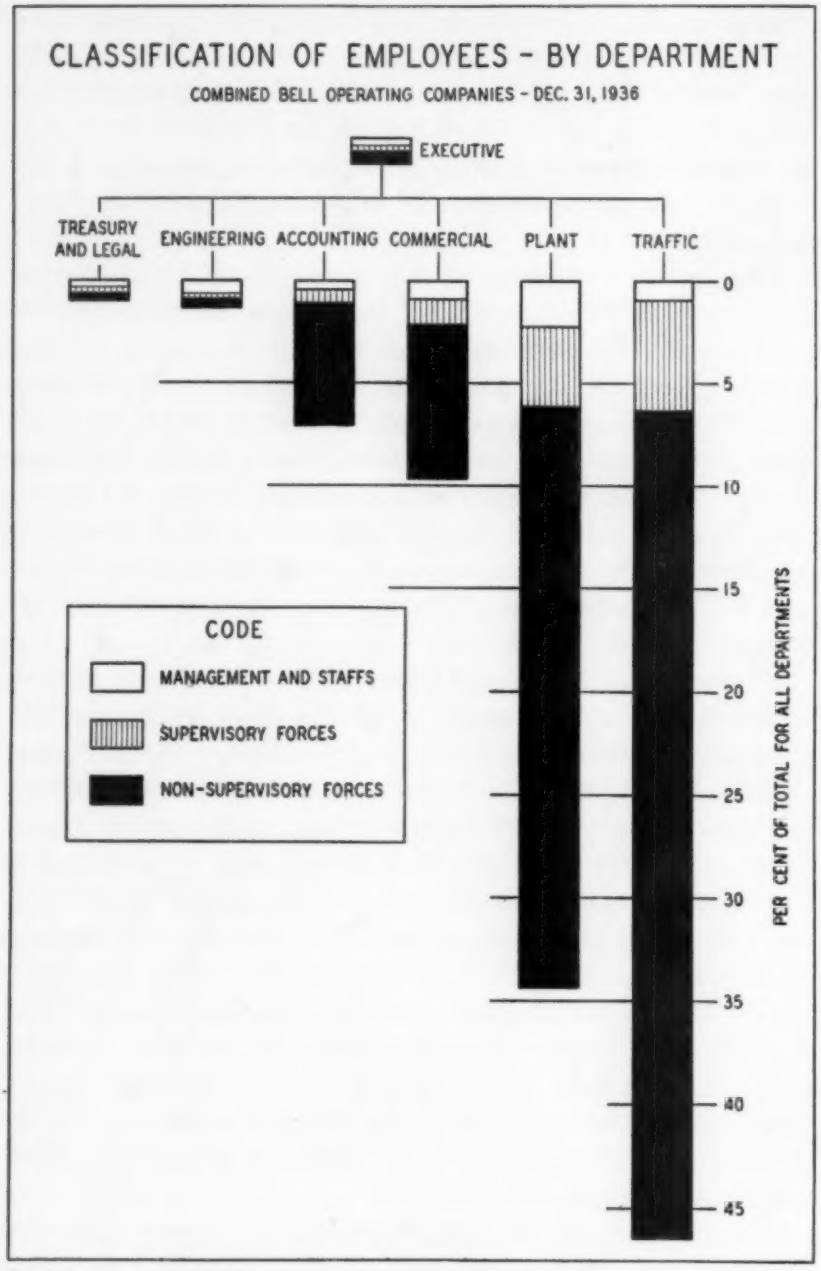
Districts are generally grouped into divisions under the direction of a Division Traffic Manager. His responsibilities consist largely in supervising activities in the districts, to insure the continued maintenance of satisfactory service and costs. Other activities include coordination of the work between districts, preparation of division budgets, the development of the supervisory personnel, etc. Here, again, discharge of these responsibilities calls for staff assistance. The divisions within a company or operating area are under the direction of a General Traffic Manager, who reports to the General Manager of the company or area. In the General Traffic Manager's organization, staff assistance is provided to assist him in the general supervision of the traffic operations of the company and the direction of a force of a few thousand people. They also provide the division and district forces with the necessary methods and routines for carrying on their work and plan the

amount and layout of the switchboards, so as to enable these line forces to maintain a high grade of service economically. The form of these staff organizations differs somewhat as between operating areas, depending on conditions, but the type of organization and quantity of personnel is only that which experience has shown is essential in getting the necessary work done.

This example is typical of the organization of each department of the telephone business. In each of these departments there are the so-called line forces who are putting up connections, building and maintaining the plant, carrying on the business activities, preparing bills, doing clerical work, etc., and there are the supervisory and management people, including staffs, who direct the activities of the line forces and do the planning work necessary to the effective conduct of the job. The chart on the next page is of interest as showing by departments this classification of employees in the Operating Companies of the Bell System.

The black portions of the bars show the people whose work is of a non-supervisory nature, such as plant craftsmen, telephone operators, business office representatives, clerks, stenographers, typists, etc. This group comprises over 83% of the total employees. The lined portions show the people immediately supervising the above forces, including plant foremen, traffic chief operators and supervisors, commercial business office and sales supervisors, supervising clerks, etc. This group comprises about 11% of the total employees. The white portions show the general officers and operating officials, including division and district managers, together with their operating, technical, legal and accounting staffs. The general officers and operating officials constitute about 1% of the total employees of the Operating Companies, and their assistants and staffs, roughly, 5%.

This chart shows the relatively small portion of the total organization in each department which is provided for plan-


CLASSIFICATION OF EMPLOYEES - BY DEPARTMENT
COMBINED BELL OPERATING COMPANIES - DEC. 31, 1936
EXECUTIVE
TREASURY AND LEGAL
ENGINEERING
ACCOUNTING
COMMERCIAL
PLANT
TRAFFIC
0
5
10
15
20
25
30
35
40
45
PER CENT OF TOTAL FOR ALL DEPARTMENTS
CODE
MANAGEMENT AND STAFFS
SUPERVISORY FORCES
NON-SUPERVISORY FORCES

ning, guiding and administering the work of the large organizations which are required. The relationship of the non-supervisory forces to the total varies somewhat as between departments due, of course, to differences in the nature of the work to be done.

Problems of Growth

As discussed before, the type of organization most effective in accomplishing the desired result must be determined by experience, and it is a primary function of management to make this determination. This is well illustrated by changes which have taken place in organization setup within the Bell System since its beginning. In the early days, when the business was in its infancy and the number of customers was small, the equipment and plant layouts were relatively simple, and only a small organization was necessary to provide the plant and to establish connections. All the activities necessary to provide service in a given area could be carried on under the direction of a single person. These people were called "non-functional managers" and they, with a small staff, directed the work of the operators at switchboards, the construction and maintenance men, the business office representatives and, in short, were in complete charge of the telephone service of the communities or areas. As the business grew in size, it was found that every phase of telephone operation became more complex. With the greater number of customers to be connected with each other, the switchboards and the trunk line layout interconnecting them became more complicated, so that the work of engineering and maintaining them was made vastly more difficult. The wire layouts on poles became denser and denser, leading to the use of cables and underground conduits in cities, and these things brought with them an enormous increase in engineering, construction and maintenance problems and in the necessity for a knowledge of technical details on the part of those administering this work. The training of the switchboard operators,

which was relatively simple at first, became more difficult, and new problems sprang up in the way of finding means for insuring that just the right number of operators were at the switchboards each hour of the day. Business contacts with customers also increased in complexity as various types of service and equipment were offered to meet varying requirements. The matter of starting new service for customers after the orders had been taken became a more difficult one, involving the effective cooperation of a large number of people within the telephone organization. It became obvious that the requirements of this increasingly complex job could not be met adequately with the early, simple type of organization, wherein the direction of all the activities within a community or area was centered under one head. As a result, the organization was divided up into departments, each department being made responsible for a particular part of the total job as follows:

The *Traffic Department* was given the responsibility for directing all the work relating to the actual establishment of connections. This included the hiring and training of the switchboard operators and the direction and supervision of the operating work. It also included determination of the amounts of equipment required and its arrangement.

The *Plant Department* was given responsibility for constructing and maintaining the plant and installing telephones on customers' premises. This involved the organization, training, and directing of a large force of plant men with all its related problems.

The *Commercial Department* was given the responsibility for carrying on the company's business relations with customers. This involved, among other things, the maintaining and manning of convenient business offices with its related problems and the conduct of sales and collection activities.

The *Engineering Department* was given the responsibility for planning the layout of buildings, central offices, outside plant, etc., necessary to meet the requirements for telephone service and to study and plan for expansion to meet the growing telephone needs of the public. This involved the training of a force of people in technical processes and engineering detail.

The *Accounting Department* was assigned the responsibility for keeping the accounts and billing the customers and for maintaining the books of the company.

These were the major subdivisions that the work made necessary. Each of these departments, except Accounting, was headed up by one man within a company reporting to the General Manager or Operating Vice President of that company. They were known as Traffic Managers, Plant Managers, Commercial Managers and Chief Engineers. Each of the "operating" departments, namely, Traffic, Plant, and Commercial, in turn found it desirable to break up their organization into divisions and districts for administrative purposes along the lines already indicated. The Accounting department, in addition to a number of smaller general departments, i.e., Treasury, Legal, and Executive, were headed up by officials reporting directly to the President of the company. This form of organization had the advantage over the former simple non-functional organization of bringing each specialized phase of the business under the specific direction of people specially trained in the requirements of that particular work, and for many years this form of organization adequately met the requirements.

As the business continued to grow, new factors came into the picture which made it desirable to consider the possibility of modifying this form of organization in some places. Chief among these was the fact that in some companies the operations covered such a large expanse of territory that the direction of all activities under one General Manager did not permit suf-

ficient attention to be given to the specific needs of all parts of the territory. For example, the problems in the big cities had become so great that they tended to require the larger portion of the time and attention of the General Manager and his department heads to the possible detriment of other parts of the company's territory which, though less important in the company's total operations, were nevertheless important from the standpoint of the customers in those parts.

Because of this situation, a number of the companies modified the former organization by dividing their territory into two or more parts, each under the direction of a General Manager, reporting to an Operating Vice-President. These newly formed General Managers' areas were known as "Operating Areas" and within each the traffic, plant, commercial and engineering activities were headed up by a Traffic, Plant, and Commercial Manager and Chief Engineer reporting to the General Manager of that area. It might seem at first glance that this change which increased the number of directing heads within a company was merely building up more "overhead" and therefore, undesirable and uneconomical. As a matter of fact, this change was made only after management had convinced itself that the net result would be favorable to the service and the business as a whole.

This is a good example of the evolutionary approach to the problem of organization in the Bell System. Fundamental considerations are that:

(1) organization is merely a means to an end;
(2) the proper organization to do a given piece of work can only be determined through experience;
(3) organization must be adapted to the specific needs and changed as the need changes; and
(4) it is a primary function of management to determine that type and quantity of organization required to do the job at any given time.

In addition to the 275,000 employees in the organization of the Operating Companies, which has just been described, there are some 45,000 people in the centralized manufacturing organization and about 6,000 in the General Departments of the American Company and Laboratories. These latter may be compared to the general staff of the Army, which is constantly studying methods and procedures of conducting adequate defense and developing improved equipment for use by the line forces. The same principles of organization apply to them as discussed above for the Operating Companies, namely, that the organization setup, both as to type and quantity, is that which management has determined from experience is necessary to do the work which has to be done. While their function is purely staff, as contrasted with the line function, it is just as essential a part of the total operation as that of establishing connections at switchboards, building a pole line across the country or negotiating with a customer for telephone service.

The Management

In connection with these remarks on the organization setup which makes the Bell System so effective, there is another happy result that is worth pointing out. This is that when responsible and experienced management has created an adequate and basically sound organization, it has provided for its own skilled and trained successors.

The Bell System has found practically all of its management among those trained and proved by firing line experience, with judgment and leadership developed through the lower supervisory positions. The principal Bell operating companies have a top supervisory group totalling 99 officials—presidents, vice-presidents and general managers. The 18 presidents have averaged over 34 years each in the telephone business. Every one of them started on the firing line as a young man and the average starting wage was under $11 per week. The entire

group of ninety-nine has a service average of thirty-one years, or more than 3,000 accumulated years of telephone experience. Yet superannuation is no problem, as thirteen achieved their present title by age 40 and only two will reach the automatic retirement age of 65 during 1938.

Three major advantages are derived from an organization setup which constantly feeds upward management replacements:

The resulting management understands the organization required by the business and has a long tradition of service.

The organization has confidence in the management.

Job inspiration is provided throughout the organization when the ladder of advancement is open all the way to the top.

In the group of ninety-nine officials already mentioned, many have gained their first-hand knowledge of organization by working in two or more departments. Thirty-five have had Plant experience, thirty-one Traffic, thirty-one Commercial, twenty-seven Engineering, as well as varied periods in other phases of the business. In addition, intimate knowledge of organization has been promoted by transfers between different territorial sections of a company and to other Bell Companies. Nineteen of these officials have worked in the territories of four or more principal telephone companies. Their present knowledge of other telephone organizations besides their own leads to further progress and closer cooperation.

Employees at lower supervisory levels have confidence in a management which can talk their language, which has previously worked at the very job they are now handling. Telephone executives constantly experience telephone calls or visits from employees in every level of the organization. Red tape has little chance in the face of such personal contact. The man down the line knows that an experienced management is

planning the future and that his suggestions and criticisms will be welcomed.

The employee is spurred by the genuine prospects for advancement in his organization, as exemplified by the management group. Democracy of opportunity is self-evident; there are no barriers of birth or education or other artificial factors. Of the above ninety-nine officials, six were born in foreign lands. The rest were born from coast to coast and border to border, in twenty-six different states. They started telephone work as engineering assistants, service inspectors, traffic students, repairmen, installers, night operators, collectors, draftsmen, stenographers, special agents and in a variety of other jobs. Twenty-eight were enlisted in telephone work before they reached voting age.

With such interesting statistics to prove that the management of the Bell System has, and always can "come up from the ranks," it is evident that the System has developed an organization that meets both the demands of the present and the responsibilities of the future. As was said at the beginning of this article, the building of such a structure for service is an outstanding accomplishment of the System's management. Perhaps it is one of the things that a professor at the Harvard School of Business Administration had in mind, when he spoke of the Bell System as "a modern miracle which I can only explain to myself by assuming that the men who conceived, created and have developed the telephone were men of the rare auto-motive type whose driving power came from within."

E. E. Browning, Jr.

Some Unusual Telephone Construction Problems

"MODERN conveniences such as the long distance telephone," recently wrote an editorial writer in a Washington newspaper, "are taken quite for granted. Who for example, ever wonders where the lines connecting Washington and, say, Alexandria, cross the Potomac?"

To ask the question is, of course, to suggest the answer. For nobody wonders about the location or routes of the circuits that stretch in all directions, the significant reason being that in the United States a universal telephone service is accepted as a normal aid to living and working.

In fast moving America it is natural to assume that one can go any where, by telephone, and the use of 3,000,000 toll and long distance conversations every day shows the extent to which this assumption is translated into action. With everyone confident that the circuits are ready, for routine or emergency, it is not surprising that their underground or overhead pathways should be matters of interest chiefly to those engaged in the professional tasks of communication engineering and construction.

A thoughtful traveler, observing through the window of his train or automobile a procession of telephone poles, would of course sense some of the romance of communications if informed that he was viewing one of the transcontinental telephone lines, or that the cable paralleling his travels was bringing to a far flung network of broadcasting stations a radio program addressed to a national audience.

But even such definite information, though possibly suggesting the accomplishments of scientific research, or the alert watchfulness of an army of people whose creed is that "the

message must go through," would give no hint of the varied activities that actually presented the communications art to the national service—namely, the actual construction of the telephone facilities that our business and social needs have called into being.

That engineering skill and ingenuity have been needed in full measure is abundantly evident to one who can read the country's map with an imaginative eye. For a message to "go through" it must have an electrical pathway to follow. That pathway may blaze strange trails, may strike across untamed terrain, through swamps, under rivers or over mountains. Means must be provided by which those communication highways may go where telephone engineers want them to go, no matter what nature may say to the contrary nor how much man-made obstacles may hinder.

It may be illuminating to examine a number of specific problems; to see the ways in which they have been attacked, the solutions which have been reached.

Nature in the raw was especially well represented when the transcontinental line construction encountered the Great Salt Desert between Salt Lake City and Wendover. In this region there are two peculiarities: salty mud flats and solid beds of salt, four feet thick and hard as rock. At times, these are covered with as much as twelve inches of water, presumably blown by heavy winds from Great Salt Lake and either blown back to that body of water by a change in wind direction or disappearing slowly through seepage. The salt does tend to preserve poles, though it gives them a curiously cracked appearance; and, of course, it prevents maintenance troubles due to animal life. Those were the only advantages offered by the situation.

Of disadvantages there were many. Fresh water and provisions must be brought to construction camps from Salt Lake City. Line materials must be hauled to the job on trucks equipped with special broad bands to prevent them from sink-

ing in the soft mud. On occasion, only one pole at a time could be loaded and this had to be removed from the trailer which bore it without allowing the vehicle pulling it to come to a complete stop. Salt was so caked on automobiles after the day's work that, to prevent corrosion, it had to be removed with a steam jet. The mud, the salt spray and the unpleasant odor combined to produce difficulties for construction gangs.

In addition to unfriendly ground, there were known to be very high winds at certain seasons. To circumvent trouble from a combination of wind and water "H" fixtures were constructed at every tenth pole and ground bracing was placed at the bottom of certain intermediate poles to keep the line true.

These "H" fixtures, fashioned by setting up two poles connected by cross-arms, are often employed elsewhere when extra strength is demanded. For example, over the Santo Domingo wash in New Mexico two tall "H" fixtures are used to swing telephone wires clear of danger. This section of the inter-city route is a catenary long span, which is a short way of saying it is a special suspension bridge for carrying telephone wires only.

When it rains out in that high plateau country, it pours incessantly. Fearful torrents rush through the larger canyons carrying great boulders and trees in their raging flood. Such rains do not come often, but when they do, everything is swept before them.

Halfway between Santa Fe and Albuquerque lies the Santa Domingo wash, a natural drainway. Crossing it is an important transcontinental telephone route and also the Denver–El Paso circuits. On each bank of the wash are "H" fixtures: one made of sixty foot, the other of fifty-five foot poles. The length of the span between them is 1,024 feet.

These supporting fixtures were assembled on the ground. Poles, saddles, steel crossarms and guy wires were all bolted into position. As a unit it was then raised by special rigging mounted on a winch-equipped truck. Supporting strands (there are four of them) are carried over the saddle and an-

chored with large concrete blocks. It is important that these anchors do not move in the earth—do not, as it is called, "creep"—under the loads which may be encountered.

The long span, strong enough to withstand storm conditions, swings the line clear of the wash even at the height of a flood. So that the span may be worked on at any time, standard lineman's cable cars are kept in readiness at each end of the section.

The longest open-wire catenary span in the world is that which crosses the Gila River between Duncan and Globe, Arizona. Measured from one 100 foot steel "H" fixture to the other 75 foot one, this span is 2,373 feet long—almost half a mile. The level of the Gila River varies considerably with the rainfall. The catenary span was decided upon instead of either an aerial or an underwater cable, for cable would have necessitated placing loading pots in mid-stream.

Between the two great steel "H" towers, set in enormous bases of concrete, are suspended two one hundred and eighty thousand pound stranded steel messenger cables. It is these which support, at intervals of 167½ feet, thirteen fixtures each made up of three standard crossarms. On them are strung the telephone wires. The lowest wire clears the river bed by thirty feet—ample allowance for variations in level in the Gila. Ordinary open wire construction for a section of line as long as this would call for thirteen or more poles.

Some idea of the massiveness of this unusual piece of work may be gained by consideration of a few statistics. Each of the stranded steel supporting cables weighs 3.7 pounds per foot. The two reels, including the steel cable, weighed 12,000 pounds each. The job called for the excavation of 680 yards of earth, the fabrication of 75,000 pounds of steel-work, 750 sacks of cement, 185 tons of gravel, and 130 tons of sand. Altogether, a sizable undertaking.

One would have to search far to encounter a more interesting piece of construction, in which cable was involved, than the conduit leaving Manhattan Island to cross the Harlem River.

Housed in it are the main toll circuits from New York City to New England, as well as trunk circuits connecting various exchanges in the vicinity of the metropolis. It was important, consequently, that provision be made for rapid replacement of any cable that might develop conductor trouble. Briefly, hazards were obviated by the following means:

A pipe tunnel, 614 feet long, with walls 1¾" thick and an inside diameter of seven feet, was buried in a trench so deep that the top of the structure was 27 feet below mean water level. This insured protection against injury by future dredging operations in this navigable channel. Twelve foot lengths of the pipe were assembled near shore into 72 foot lengths and these units, each weighing some 720 tons, were lowered into position by floating derricks. The sections rested upon cast iron saddles, spiked to a cap built upon timber piles. The pipe tunnel at each end consisted of approximately 75 feet of curved section. After divers had sealed its joints with lead, and a coating of from 18 to 24 inches of concrete had been applied, the iron tube was pumped out, dried and tested. It was then ready to hold the cable ducts, and was completely filled with conduit, a total of 206 ducts.

Another novel solution to a problem in cable construction was reached when the Miami River was crossed by means of conduit, buried 22½ feet below mean water level.

The river flows through the town of Miami. A number of submarine cables crossed it. Growth necessitated additional cable crossings and 3½-inch black steel pipe ducts were decided upon as being more practical than further increase in the number of submarine cables.

The site selected was near Flagler Street, where the river is approximately 240 feet wide and the channel (the Miami River is navigable) some 15 feet deep. Pipe for the project was delivered in short lengths. These lengths, placed upon a temporary dock to facilitate handling, were welded together to form 18 pipes, each about 270 feet long. The 114 welds were pres-

sure tested and the pipes then shaped so that they were straight for 170 feet in the center and sloped upward at each end to fit manholes located on each river bank. The finished pipes were then clamped together in a stack three ducts wide and six ducts high.

In the meantime, a bucket dredge had dug a ditch across the river bed and was ready to receive the conduit. By means of a steel beam "strong back" with outriggers, one floating derrick was able to lift the assembled pipes from the temporary dock and to lower them into position in the ditch. The ditch was back-filled with the soft rock that had been removed from it; the completed job was checked by divers; and the conduit was ready for lead-covered cable to be placed in it, in a manner similar to the laying of underground cable.

Problems are often solved on the draughting-board before material is delivered to construction forces in the field. The fourth submarine telephone cable link between Key West and Havana is a good case in point.

This cable, an improvement over earlier ones, is non-loaded and employs a thicker paragutta insulation than formerly specified. Six thin copper tapes are wound spirally on a central copper wire. The continuity of the circuit is therefore assured. Melted rubber, following passage through a vacuum chamber, fills the interstices between tapes and central conductor. In case of a rupture, water would not be likely to travel far along the conductor. Paragutta goes on next, followed by cotton tape. Copper tape is next wound on with a slight overlap and this is a protection against the teredo or other submarine borers. Over this copper tape six heavier copper tapes are wound spirally without overlap to provide the return conductor.

Three different types of armoring were used: one for depths not exceeding 1,000 feet; another for a depth of 1,000 to 2,000 feet; and a third for depths greater than 2,000 feet. The first of these consists of 12 heavy iron wires, .3-inch

in diameter. The second is made up of sixteen smaller iron wires—about .2-inch in diameter. The deep water section is armored with 22 wires of high tensile-strength steel, each little more than .1-inch in diameter and each covered with a fabric tape as a protection against corrosion. Over all three types of armoring were applied finally two layers of jute.

The cable was made with as few joints as possible. Most of the splicing was performed on a special jointing machine before delivery to the cable-laying crews. Shore type cable, six miles of it, was laid first. This was paid out from a barge until the cable ship, which could not anchor closer to shore because of shoal water, was reached. A splice was then made to the main cable and, early the following morning, the cable ship started on a course which it had previously sailed over and marked with buoys.

One of the most original construction projects undertaken in recent years was in connection with a change in address of an office building. The eight-story, 11,000 ton structure, housing the general offices of the Indiana Bell Telephone Company at Indianapolis, was pushed 52 feet farther back on its lot and then turned 90 degrees. Six hundred employees inside the building carried on as usual during the move.

Elevators ran up and down; gas, steam heat, water, electric power—all such facilities were maintained by flexible connections; and long distance telephones, spliced to lengths of armored submarine cable to allow slack, operated without interruption. Visitors came and went, entering and leaving by means of a "drawbridge" at the entrance, which pivoted as the building changed position.

The 59 steel columns supporting the building were reinforced with 500 tons of structural steel so that they could not shift in their relationship to each other. A concrete mat, overlaid with 6 x 8 fir timbers and surmounted by steel rails, formed the surface upon which the building was rolled. The rollers were placed under steel shoes on each side of the supporting columns

and I-beams were affixed to help distribute the load from column to roller. A total of 4,000 rollers was employed.

Eighteen 100-ton and 75-ton jacks of the ratchet screw type, placed strategically and operated by 18 men, moved the building with ease. Jacks were reset after every foot of the journey.

This relocation, which allowed space for a new building and at the same time saved the cost of moving the Indianapolis repeater station and offices, was so intriguing to the public that a viewing stand was provided for the benefit of the curious. It was filled with interested spectators daily.

On the Albany-Catskill conduit route for underground telephone cables, there are a number of unusual construction devices. This conduit line is, for the most part, on private property, which in itself is somewhat out of the ordinary. Swampy spots were traversed by above ground fills, with the material for filling frequently brought from a distance. Special culverts carried the conduit line over streams and extra precautions had sometimes to be taken to insure good drainage. This story, with technical thoroughness, was covered in the BELL TELEPHONE QUARTERLY for January, 1931.

However, few conduit construction jobs have been more novel that that accomplished when Flatbush Avenue, Brooklyn, from Avenue U to Barren Island was lowered three feet and repaved. The customary procedure in the past when a duct line had to be set at a deeper level, called for blocks, screwjacks or chain hoists. Rather extensive repairs followed, for concrete top and bottom slabs, tile conduit and mortar joints are all brittle. But this duct line was laid delicately in place in its new home without any of these tools. Ice was the miracle-worker. Two tons of it, regular family-refrigerator grade.

This is what happened. First, the duct line was uncovered. Then, at intervals of six feet, pits were dug to the new depth required. These were filled with ice. As the earth between the ice slabs was removed, the duct-line was supported as it were on jacks of ice. The pressure of the cable structure itself and the warmth of the air did the rest. In 48 hours the

ice was melted, lowering the line so evenly and gently that breakage was negligible.

Pole lines, as everyone realizes, represent a substantial part of outside plant investment. Methods by which the cost of such lines may be reduced, therefore, constitute significant contributions to telephone efficiency.

With the advent of toll cable lines, with strong supporting strand, low wind resistance and long stretches through open country, it was apparent that the length of spans could be increased above the usually accepted limits of "forty poles to the mile." Within the past several years a number of cable lines have been strung on poles set from 250 to 360 feet apart. The "normal" pole interval is about 130 feet. The saving in first cost is obvious. A thriftier maintenance record is to be expected as well, for long span construction tends to lessen the degree by which cable is subjected to the effects of tension and compression arising from changes in temperature.

The setting of poles frequently taxes the inventiveness of construction forces. Ordinarily, holes may be made rapidly by machine. But when mountain regions are being traversed and rock is encountered, blasting must be resorted to; while poles set in boggy land must, sometimes, be erected upon foundations especially created, such as pilings capped with concrete slabs.

All telephone construction and, indeed, every phase of telephony, is guided by a common belief. It is this: no matter what hindrances have been created by man, no matter what obstacles nature has placed in the way, they can be overcome. This guiding principle does not admit of defeat. It accepts only the limitations of the state of the art and, as the boundaries of fundamental knowledge are constantly being pushed back, it accepts those limitations only tentatively.

Such an attitude inspires, in telephone-worker and telephone-user alike, a vast measure of confidence in the ability of the art of communication to grapple with the inevitable problems of the future.

STERLING PATTERSON

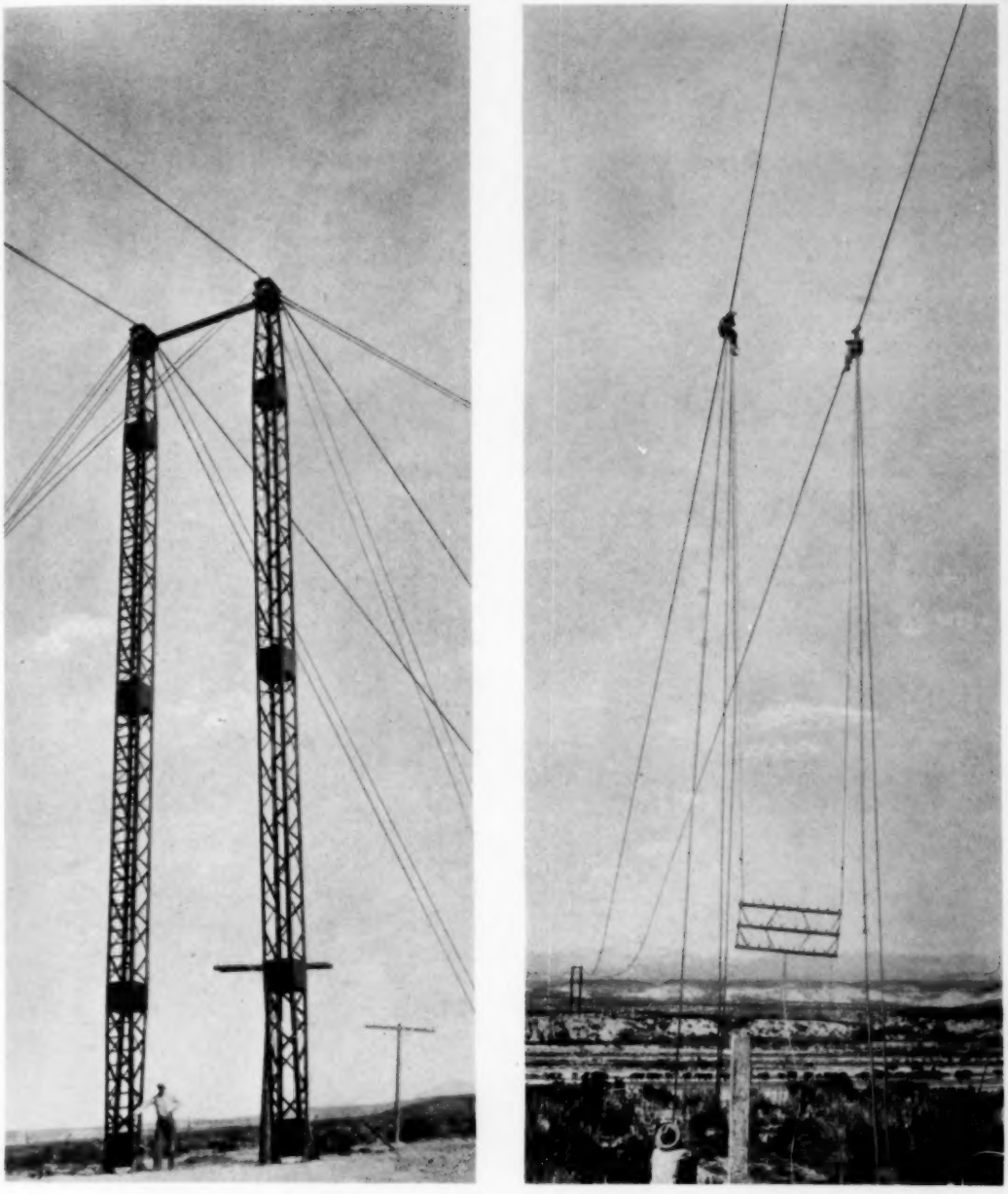


FIG. 1. THE GILA RIVER CROSSING IS THE LONGEST OPEN-WIRE CATENARY SPAN IN THE WORLD. THE LEFT VIEW IS LOOKING UP THE STEEL COLUMNS ON THE NORTH SIDE OF THE WASH DURING CONSTRUCTION. AT THE RIGHT THE SIZE OF THE WORKMEN, AND THE PROCESSION OF CATTLE, SUGGEST THE GREAT LENGTH OF THE SPAN.

FIG. 2. PLOWING IN BURIED CABLE ARMORED AGAINST NATURAL AND MAN-MADE HAZARDS.

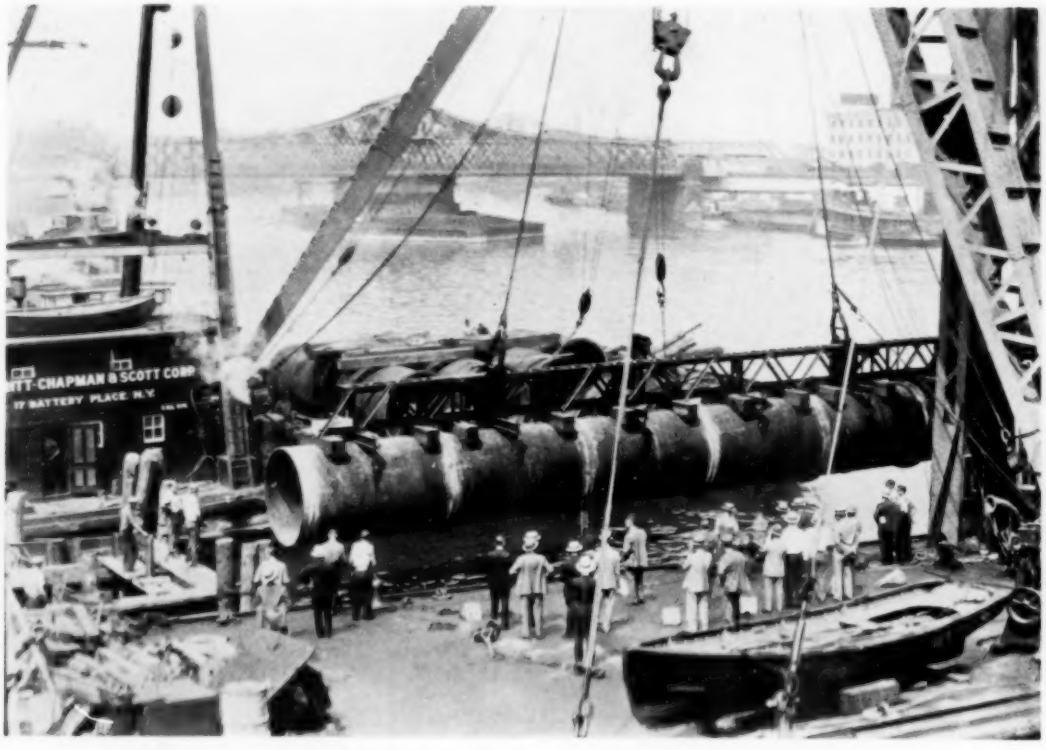


FIG. 3. THIS TUNNEL, EXCLUSIVELY FOR TELEPHONE CABLE, WAS LAID UNDER THE HARLEM RIVER FOR TALK CHANNELS OUT OF MANHATTAN ISLAND.

FIG. 4. THE CABLE-LAYING BARGE AT KEY WEST SHOWING THE HUGE LOOPS OF TELEPHONE SUBMARINE CABLE AND THE BALLOON BUOYS. THE INSERT SHOWS ONE OF THE THREE DIFFERENT TYPES OF SUBMARINE CABLE WITH VARYING PROTECTIVE COATINGS THAT ARE NECESSARY BETWEEN KEY WEST AND HAVANA.

FIG. 5. EIGHTEEN MEN WITH JACKS PUSH 8-STORY, 11,000 TON BUILDING. THIS PICTURE SHOWS THE START OF THE STRAIGHT MOVE SOUTH.

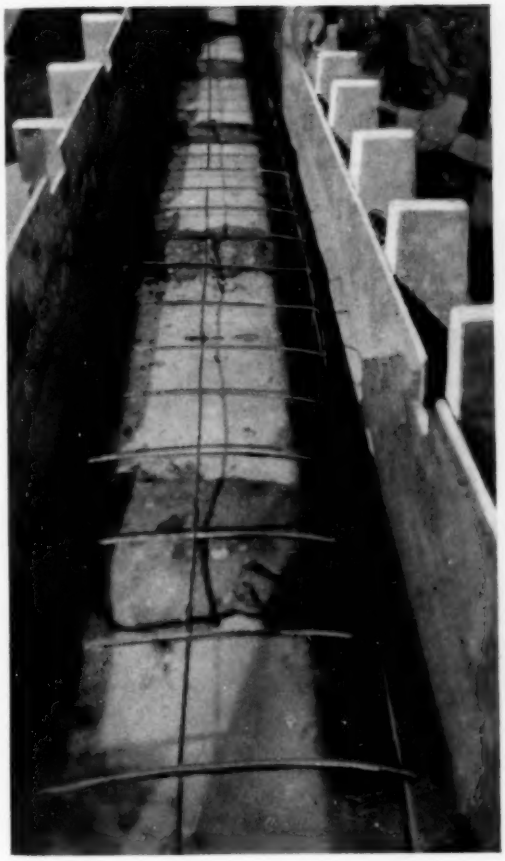


FIG. 6. THREE CONSTRUCTION VIEWS OF THE PROTECTED UNDERGROUND ROUTE FOR TELEPHONE CABLES BETWEEN ALBANY AND CATSKILL. IN PLACES IT RESEMBLES A ROMAN AQUEDUCT AS IT CUTS THROUGH SWAMPS AND FORESTS AND BRIDGES STREAMS.

FIG. 7. PART OF THE MECHANICSBURG-SHEPHERDSTOWN, PA., TOLL CABLE, WITH THREE-HUNDRED-FOOT SPANS, SHOWING HOW IT IS POSSIBLE TO UTILIZE HIGH SPOTS IN THE CABLE ROUTE FOR PLACING SHORT POLES.

FIG. 8. USING BLOCKS OF ICE TO GENTLY LOWER OCCUPIED TELEPHONE CONDUIT IN ORDER TO PERMIT CHANGES IN HIGHWAY GRADE NEAR FLOYD BENNETT AIRPORT, NEW YORK.

The Collected Papers of George Ashley Campbell

(Editor's Note: A volume containing the technical papers of Dr. George A. Campbell has just been issued by the American Telephone and Telegraph Company. The publication is commemorative of Dr. Campbell's long and distinguished service as Research Engineer of the Company and of his fundamental contributions to the development of telephone transmission.

While the volume as a whole will appeal primarily to the specialist in transmission theory, it carries two introductory chapters which, because they are historical in their point of view, will be of interest to a much wider circle of Bell System readers. The QUARTERLY *welcomes the opportunity, therefore, of reprinting these chapters. The first is by Professor Vannevar Bush, Dean of Engineering of Massachusetts Institute of Technology, while the second is by Dr. Edwin H. Colpitts, for some years Executive Vice President of Bell Telephone Laboratories and himself, like Dr. Campbell, but recently retired.)*

FOREWORD

GEORGE A. CAMPBELL has lived and worked in a period during which there has been unprecedented progress in the application of the products of scientific effort to the needs of mankind. Of these products none has led to a more brilliant and serviceable accomplishment than that which brought about the telephone, or more generally, electrical means of communication as we know them today.

The telephone could never have reached its present state of serviceability if it had not been for the vision of those who early guided the epochal invention of Bell into a healthful relationship with its underlying scientific principles. The realization of new materials, and the invention of new combinations, has influenced its development enormously. The telephone has grown vigorously however, largely because in a great country it has been nurtured in accordance with the best scientific

tenets. Those whose vision is responsible for our telephone system of today evolved these tenets at a time when in this country at least science had little respect from the multitude.

As a matter of history, it seems clear that as the results of scientific progress come to be of direct utility in everyday affairs there are two stages. One of these, the first, has little popular appeal. It includes the processes of interpretation and adaptation of the broad disclosures growing out of profound creative study—a study that is classical and painstaking. There follows this first stage a second, which includes the introduction into commerce of new mechanisms based on foundations laid by classical study. The earlier work, although often of equal brilliance in comparison with the later applications, is appreciated by only a few, and understood in but a superficial manner, if at all, by the vast group that may be termed the public. On the other hand, the introduction into the practical world of an idea culminating from a long developed scientific background is often received with acclaim. Curiously enough this lauding is usually greater the less the principles underlying the idea are understood.

Industry often scratches about the roots of advancing science, finding serviceable devices here and there, or merely attempts to break off the useful buds of a growing tree, thus retarding future growth. This, it seems, has been the traditional American way of doing things, to which fortunately there have been outstanding exceptions. As the country grows older and more mature in its approach, and as it becomes more and more difficult to carry on by superficial contact with the guiding logic of creative thought, there will be a sounder type of activity in this intermediate region between basic science and the ultimate industrial application really depending on science.

In our economic history there are a few cases where a group of industrialists has grasped a body of science as its own, advanced it into new fields, and reaped the results in a thoroughly intelligent fashion; yet when this has been done the fruits have

been great. After all, this exploitation of the vast contributions of science by those who through preferment serve the practical needs of mankind is in the sound way of progress. The day of the industrialist who is a dilettante in science is nearly done. Even in its formative period the telephone company had fully grasped these principles.

It is felt that it is necessary to have this background before us if the position of George A. Campbell in the scientific and engineering fields is to be understood and appreciated. He has been a pioneer and a representative in industry of a rare group of whom there must be many if we are to proceed in the future as rapidly as in the past.

When Heaviside wrote his electrical papers they were read by only a few, and of these still fewer understood or were willing to recognize the scintillating bits of thought because these thoughts were mounted in a matrix which was faulty in its rigor. Of those who understood, only two or three grasped the meaning of Heaviside's work to such an extent that they could interpret it, reduce it to a sound basis, and make it truly serviceable.

In order that there may be great commercial advances, it is always necessary that there be an individual with new thoughts and a setting in which they become commercially feasible. In Heaviside's day the time was not ripe for great communication systems, nor were men of his time receptive to what appeared to be radical departures from convention. Unless there had been prophets to see the light and to carry it over into the new day, the great work of Heaviside would have been lost. These men who carried the torch can be numbered on the fingers of one hand, and of them Campbell stands out as the predominant figure, not alone because his grasp was sound and persistent, but also because he was associated with those who by transportation and communication developments were beginning the great work of joining America into a single nation.

Into this early advance, to meet a commercial exigency, came the loading of telephone lines. The vision was Heaviside's The design formulæ were Campbell's. Out of a mathematical argument came coils of the right size and in the proper places to enable wires to go underground and to carry speech to long distance.

It is difficult in retrospect to appraise and appreciate the intricacies of this accomplishment. Today we think in terms that have acquired meaning and visual power by long use. At that time the problem was very largely abstract. It is true that electrical configurations are more adaptable to mathematical treatment than are mechanical, for in the former, measurements are more readily and precisely made. Hence the application of mathematics to electrical engineering problems may and does proceed to complex things, for its premises may be checked and its predictions verified. Yet it was a long road from the bare idea of continuous loading, or even the suggestion that the loads might be discrete, to a working cable or open wire line with the proper loads at the correct spacings.

Empiricism here would have been utterly hopeless and unjustifiably expensive. One cannot temporize with a long transmission line running across actual country by trying this and replacing that. Haphazard work of that nature could have but resulted in discouragement and failure. Procedure by thoroughly rigorous mathematical treatment to the condition where operation is understood, is the necessary step if the result is to be practically accomplished. For this, Campbell, and Campbell almost alone, deserves the credit. He gave us the loaded line.

Directly out of this development followed the filter. The mathematics of the loaded line and of the filter are of the same genus. He who thoroughly understands one will know the other. If coils can assist they can also impede, and a change of sign or a shift of variable is no great effort to the mathematician. But in order that the filter might emerge, the grasp

needed to be complete. It was because Campbell was a pioneer in understanding of the phenomenon of propagation of guided electrical waves that the filter was to him a natural next step.

The separation of electrical components of differing frequencies is so commonplace today that it is hard to realize that it was not an immediate extension from the ideas of optics. Yet optics had not dealt with two-dimensional wave systems and interlaced networks. Also new definitions, new concepts, new interpretations became essential before the partition of electrical frequencies could become as productive in results as the separation of colors in the spectrum. Campbell's physical theory of the electric wave filter which culminated in his publication in 1922 marked the advent of a new understanding of the subject.

Just as Campbell's "Loaded Lines" in the *Philosophical Magazine* in 1903 had marked the appearance of a new school of thought in transmission, so his "Cisoidal Oscillations" in the *Transactions of the American Institute of Electrical Engineers* in 1911 opened up a new and powerful manner of considering circuits generally.

Heaviside had initiated the algebra of transients. He had created a new way of bringing within the range of analysis the oscillations in electric circuits. Had it not been, however, for those who interpreted, applied, and strengthened his scheme of thought, it would never have become utilized. Heaviside was the pioneer, and then came a few such men as Campbell to place the matter on a sound footing and make it useful. True, mathematicians had long manipulated Fourier series and integrals, and there had been generalizations based on the use of the Fourier transform. To render a far-reaching tool of this sort truly useful requires, however, much more than merely formulæ of pure mathematics. Oftentimes he who interprets and amplifies deserves as much credit as he who first grasps a mathematical generalization for having overcome obstacles equally great.

One estimate of a creative thinker is based on the extent to which he influences the thoughts of those who follow and who also think profoundly. The entire telephone technical personnel, when dealing with oscillations, now think in terms brought into their midst by Campbell. That some of these thoughts might be useful as well as clear led to the publication with Foster of "Fourier Integrals for Practical Applications."

It is not necessary to deal with each of Campbell's contributions, for the group of papers of which this is the foreword tells its own story. He has lately worked in that baffling field of endeavor aimed at sorting out and precisely defining the units with which we deal, and in many other aspects of our present procedure. Most clearly, however, he stands out as the one to whom the telephone art owes the realization of the loaded line, the electrical filter, and the facile treatment of the transients which pulsate in its networks, and as a modest, generous character who by his very nature has inspired others to broaden into a highway the trail which he brilliantly blazed into the vast reaches of Science and Engineering.

VANNEVAR BUSH

INTRODUCTION

IN all its more important elements, the present plan of organization of the Bell System had evolved within a relatively few years after the invention of the telephone by Bell. Then, as now, adaptation to the unusual requirements of the telephone business was accomplished by an organization having licensee operating telephone units and a manufacturing unit grouped around a parent company. From the beginning the parent company assumed certain obligations and service functions, among which was the active prosecution of technical research and development to improve the telephone art.

Passing over the initial stages of research and development, by 1897 the American Bell Company, whose functions as the parent company were later taken over by the American Tele-

phone and Telegraph Company, had, by gradual steps, built up a research organization of physicists, chemists and engineers. This organization in 1897 was located in Boston and was under the direction of Dr. Hammond V. Hayes. To us in 1937, Dr. Hayes' department possibly appears as a small group, but as late as 1897 organized industrial research was scarcely known outside of the Bell System, and in those days the Bell System had 325,000 stations as contrasted with over 14,000,000 stations today.

Forty years ago, two aspects of the transmission problem were recognized as particularly pressing. Long distance telephony had come to be a substantial business, but line costs were high, and a practical commercial range did not much exceed 1,000 miles. Hence the two major objectives were to secure better and more economical circuits with the possibilities of reaching greater distances. Of even greater importance, with the rapidly expanding telephone business in and about the larger cities and in the more densely populated sections of the country, it had become necessary to place telephone circuits in cables. To maintain reasonable transmission constants and to extend these cables to all points where their use was indicated meant a very large expenditure for many of the operating Bell companies. This second phase of the transmission problem has continuously received great emphasis with outstanding results in savings. Dr. Hayes, facing these problems and appreciating the need of adding to his staff one who had a working knowledge of the most advanced electrical theory recently developed by Maxwell, Kelvin, Weber, Heaviside and other mathematical physicists of the 19th century, employed a young man, a graduate of the Massachusetts Institute of Technology with five years of advanced study at Harvard, Paris, Vienna, and Göttingen. For the communication industry, the step taken and the choice of Dr. George A. Campbell were most fortunate and timely.

Soon after his employment by the Bell Company, Campbell found himself engaged on the problem of how to provide more economical and more efficient transmission circuits. Appreciating the part which series inductance plays, his thought naturally led him to study the suggestion that inductance be added in the form of coils properly designed and introduced at intervals in series in a telephone line. Campbell's study of this problem both by mathematical and experimental methods was carried out quite independently and in ignorance of work which Professor Michael I. Pupin had in hand. Both investigators finished their work and applied for patents at about the same time. Professor Pupin was able to establish a slightly earlier date of conception, the patent interference was decided in his favor, and the parent company, following its practice of making available all improvements in the art to its Associated Companies, immediately acquired exclusive rights under the Pupin patents. But it seems fair to say that Campbell's analysis of the problem was actually more detailed than Pupin's, and it led him to formulæ for the design and spacing of loading coils which were superior to his rival's, so that from the very beginning they alone were employed for the building of loaded lines in the United States. By this one piece of work performed within a relatively short time after his employment by the Bell Company, Campbell demonstrated his leadership among those applying mathematical analysis to the problems of electrical transmission, and his ability to state his conclusions in a form that the development engineer could use in practical applications.

Momentarily anticipating another important development, it may be pointed out here that it was Campbell's complete analysis of the loaded line problem that led him to a totally unexpected network—and one destined to become equally famous—the electric wave-filter. To the practical importance of the filter, I will return in a later paragraph.

The fundamental theoretical work covering the principles of loading telephone circuits was completed by Campbell in

1899. By September, 1899, the theory was confirmed by laboratory tests on reels of actual cable. Following these and many other laboratory tests, two cable circuits 24 miles in length, connecting Jamaica Plain and West Newton by a roundabout route through Boston, were equipped with loading coils. These circuits showed the expected gain in transmission efficiency and were put into commercial service beginning on May 18, 1900. Much remained to be done, however, before the large scale commercial application of the loading principle to open-wire and cable circuits was successfully carried out. To the practical development of the loading art, Campbell contributed largely at every step.[1]

The outstanding problem was the reduction of the basic principle to a practical form of coil. Many different coils were designed and tested but for one reason or another found wanting. It was recognized that an economical design for a loading coil would undoubtedly require the use of iron but there were many questions to be determined with respect to the form which the iron should take; whether it should constitute an unbroken magnetic circuit or be interrupted by one or more air-gaps, whether it should be in the form of wire, plates, or ribbon, and how finely subdivided, and what should be its characteristics—permeability, resistivity, etc. Also there were questions as to the size and shape of the coil and its core, and as to the copper windings, whether the wire should be solid or stranded and, if the latter, of how many strands and how insulated from one another.

The requirements in respect to energy losses were far more exacting than for any previous type of coil and means had to be developed for measuring the efficiency of the coils at voice periodicities.

[1] The development of the first successful loading coils and their application to telephone lines is too long a story to recount here but because none of Dr. Campbell's very early records has ever got into print I am reproducing at the end of this introductory Chapter three brief memoranda of the year 1899.

It was found that practically all these questions relative to loading coil design depended upon the quality of iron employed in the core and that better coils could be designed if iron of normal permeability and extra high resistivity could be procured. Consequently a great deal of effort was expended to find such an iron, including an extensive investigation of iron oxide. All materials of this sort proved to have undesirable properties, because of either hysteresis losses or unsuitable permeability, or because of being incapable of being drawn or rolled into the proper size. However, the work of designing a loading coil, using such materials as were commercially available, was pushed ahead.

In the summer and fall of 1900, an extended experiment was conducted by loading with simple solenoidal coils a long distance commercial open-wire telephone circuit of No. 12 N.B.S. gauge conductors between Bedford, N. Y., and Brushton, Pa., a distance of approximately 670 miles. This experiment was successful in showing marked improvement in telephone transmission by reason of the loading but the coils used were not of satisfactory design and the improvement in transmission was not as great as it should have been. The result of this experiment therefore was to emphasize the importance of the problem of loading coil design.

As the coil finally adopted for commercial loading was of the toroidal type, this review will be confined to some of the mileposts in the development of that coil upon which work began as early as August, 1899.

The toroidal type of coil had long been known, but largely owing to the difficulty of obtaining suitable core material, it was not until March, 1901, that the first satisfactory coil of the toroidal type possessing a fine iron wire core, known as "T-300," was constructed. This coil had an inductance of .25 henry and a total effective resistance at 1000 cycles of slightly over 5 ohms, about half of which consisted of eddy current losses in the iron core.

After the design of the coil had been completed, there still remained many practical problems incident to its commercial manufacture and use, such as obtaining adequate supplies of material, providing means for testing the coils in the factory, assembling and boxing the coils for installation on pole lines, protecting them from leakage and lightning, controlling cross-talk, etc.

In April, 1901, an order was placed with the Western Electric Company in New York for several hundred T-300 coils, but because of difficulties encountered in commercial production it was not until October, 1901, that a sufficient number was produced to load one New York–Chicago circuit. Two other New York–Chicago circuits were loaded with an air-core solenoidal coil known as T-350. The principal difficulties in producing the T-300 coil commercially were:

(1) Insulation of the individual No. 38 B. & S. iron wires of the core.
(2) Insulation of the individual strands of the copper winding.
(3) Measurement of energy losses in the completed coils or cores.
(4) Limiting the losses to tolerable values.

The improved transmission over the loaded No. 8 B.W.G. circuits from New York to Chicago at first aroused great enthusiasm, but after a few months complaints began to come in that the transmission efficiency, particularly in wet weather, was not holding up. Gradually it was learned that three important problems remained to be solved:

(1) How adequately to protect the coil against injury by lightning.
(2) How to insulate the coils and line wires so as to reduce the leakage of the circuit.
(3) How to coordinate the transposition system of the pole line and the loading coil locations so as to reduce cross-talk.

The solution of these three problems was worked out during the next six years, coincidentally with an extensive application of commercial loading to open-wire circuits, particularly No. 12's.

Early in 1902, the design of a loading coil for cables was taken up aggressively and, by virtue of the experience gained in designing the open-wire loading coil, proved to be relatively simple. By September, 1902, a cable between Cortlandt Street, New York, and Newark, was loaded with the new toroidal coil known as T-420, and the transmission improvement was found by test to be closely in conformity with expectations.

The New York–Newark cable offered the first opportunity for an important application of loading to cables; the art of loading was sufficiently advanced to seize this opportunity without delay. The major field for loading and the bulk of the economies following its introduction have been in the loading of cables. More than a decade ago, due to the advent of the telephone repeater and carrier current systems, loading on open-wire circuits became obsolete.

In Campbell's first successful laboratory demonstration of loading (September 6, 1899), using T-14 coils on a 35-mile length of standard 19-gauge cable, the coil spacing was such as to give a theoretical cutoff frequency of 11,000 cycles. This high cutoff was chosen to make sure that all necessary voice overtones would be transmitted. Rearrangements of the coils on the laboratory cable made it possible to test lower cutoff arrangements, as a step toward determining the minimum cutoff standards for satisfactory transmission. As a result of these tests the Jamaica Plain–West Newton cable circuit was designed to have a theoretical cutoff of 3500 cycles. The Bedford–Brushton open-wire circuit had the same cutoff. Further tests resulted in planning for a cutoff of about 2200 cycles on the New York–Newark cable. Subsequent cable loading installations were designed to have a cutoff of about 2300 cycles, a standard which was later adopted for open-wire loading in

1904. During the past twenty years, the cutoff frequency standards for loaded voice frequency cable circuits have been substantially raised. It is an interesting coincidence that the theoretical cutoff frequency of our present repeatered loaded cable circuits for broadcast program transmission is almost identical with that used in Campbell's first experiment with T-14 coils on his laboratory cable.

As noted above, with the introduction of loading, inductive effects resulting in the phenomenon of crosstalk between neighboring telephone circuits became more of a problem to the telephone engineer. While it had been shown by earlier workers that crosstalk was a complex effect of both electromagnetic and electrostatic induction in which the latter was frequently the more important, I believe Campbell first reduced the various factors to such a computational basis as was both accurate and readily manageable. He pointed out the importance of Maxwell's capacity coefficients and coined the term "direct capacity" now modernized to "direct capacitance." He showed in these early memoranda that crosstalk between two circuits depends to a considerable extent and particularly in the case of loaded lines on a function of the various direct capacities between the wires of the two circuits. He termed this function the "direct capacity unbalance." Campbell's studies led not only to mathematical formulæ but to the development of measuring apparatus which was destined to play a great part in the future telephone developments. In this period he produced his well-known shielded balance for the accurate measurement of electrical constants at telephonic frequencies. Out of this grew a simple method for measuring direct capacities, and also the well-known capacity unbalance test sets which have played a fundamental role in the manufacture and installation of toll cables.

With the Campbell shielded balance, the present writer early made an extensive set of measurements of the direct capacities of a short section of 40-wire open-wire line which permitted a

simple calculation of capacity unbalances. This served for many years as a basis of transposition design.

The telephone repeater art which plays such an important part in the modern telephone plant owes to Campbell that masterly analysis of repeater circuits which laid a sure foundation for its future development. The type of line balance involved in repeater operation early attracted Campbell's attention. Before the advent of the vacuum tube, various mechanical devices, notably the receiver-microphone repeater, were intensively studied with the idea of adapting them to use as repeaters. The early repeater development involved two problems: first, to secure as nearly as possible a perfect amplifying element; and second, to adapt this element to the telephone line. What is involved in this second problem can only be appreciated by the telephone engineer who has had long experience in the transmission art. As to the adaptation of repeaters to telephone lines, various experimenters and inventors had proposed circuits to accomplish two-way telephony, and out of this prior work had come two fundamental repeater circuits, namely, that in which a single repeating element amplifies messages reaching it from both directions, and the one which includes two amplifier elements, one assigned to each direction of transmission. These repeater circuits came to be known as the 21-type and the 22-type, respectively. In the 21-type repeater, two sections of line as nearly identical as possible are balanced against each other as opposite arms of a bridge. In the 22-type repeater, each incoming section of line is balanced against an artificial line or network, thus permitting, as Campbell's analysis showed, a greater inherent flexibility as well as a greater stability. The inherent stability limits of these circuits, however, were not clearly formulated until Campbell made a study of the circuits. A memorandum written in 1912 called attention to the 22-type circuits in the following words:

> " . . . In addition to this, singing will not be introduced by any possible unbalance, however large, in either of the lines, provided

> the unbalance of the other line does not exceed a certain critical magnitude. Furthermore, the two lines connected together may differ radically in character since each is balanced separately against its own artificial line. . . . Theoretically, a given total amplification can be secured with a larger singing margin if it is distributed among a number of properly spaced points along the line rather than concentrated at a single point. For example, four equally spaced repeaters each giving an amplification of five miles might be substituted for a single repeater giving twenty miles. . . . If it became necessary merely to eliminate certain frequencies lying outside of the range required for telephony, the use of an artificial selecting circuit would seem to present no difficulty."

In the same memorandum which discussed the 22-type repeater, Campbell suggested the use of the "four-wire circuit" as a logical extension of the one-way paths in the 22-type, each extended path containing as many one-way amplifiers and line sections as desired. This was in 1912, and the four-wire circuit, although now so widely used both at voice frequencies and in the carrier art, appeared at that time to have little practical application. It was proposed as a structure possessing, relative to the other types of repeaters and lines, very great stability, and as such was recognized as of technical interest if not of immediate practical value.

Turning to the subscriber's set, we find again the indelible impress of Campbell's mind. He was the originator of the single-transformer anti-sidetone circuit which is now achieving almost universal acceptance. But more than this, he did a masterful piece of work in revealing all of the possible circuit arrangements having doubly conjugate branches, and in setting down the impedance relations of the line, network, transmitter and receiver for these various branches. This systematic analysis of the problem greatly facilitated a comprehensive survey, giving assurance that all types of circuits were being considered and that those best fitting the available transmitters and receivers were being selected. A summary of this work is to be

found in the paper entitled "Maximum Output Networks for Telephone Substation and Repeater Circuits," in the writing of which Mr. Ronald M. Foster collaborated.

Undoubtedly, one of Campbell's most important contributions is the network to which he appropriately gave the name "electric wave-filter." In 1917, a patent on this device was issued to him. As intimated above, he discovered the filter properties of an iterative network consisting of lumped reactances through his analysis of the problem of the loaded line, and to one reading his famous paper "On Loaded Lines in Telephonic Transmission," published in the *Philosophical Magazine* in 1903, it is evident that even at that early date he had begun to envisage the low-pass and high-pass wave-filters.

Today there is hardly a phase of telephone transmission in which filters do not play a part,—in most cases, a very essential part, either in the transmission apparatus or as tools employed in research. In the future art, they seem destined to play an even larger part. The property of sharply separating currents of different continuous bands of frequencies is, of course, the basis of all carrier telephone and telegraph systems. While it is possible to conceive of such systems based upon tuned circuits and other simple devices of the older art, they would at best be crude and inefficient arrangements. Other important uses for wave-filters arise in telephone repeaters, radio systems, telephotography, composite sets, laboratory and testing apparatus, reduction of battery supply noise in telephone exchanges, control of noise from electrical power and railway systems, etc.

In this brief review of Campbell's work, mention should also be made that he was one of the early investigators of antenna arrays to secure directional transmission, and that certain fundamental patents in this field were issued to him.

In recognition of the far-reaching and fundamental character of Campbell's contributions to the telephone art, his associates welcome the opportunity of showing their appreciation by arranging for this collected edition of his published technical

papers. Unfortunately, his publications by no means cover the range of his researches. He published relatively little. Many of his important memoranda were never put in that polished form which in his opinion would render them suitable for publication, and still reside only in the Company's files. It is a pleasure to be able to announce, however, that Campbell is now giving consideration to ways and means of partially filling in this gap.

In writing an Introduction for this commemorative volume, I welcome particularly the opportunity of expressing a word of appreciation regarding the man himself. And here my words convey not my thoughts alone but mirror the feelings of the many colleagues who have been associated with Campbell in the prosecution of his studies, and the much larger group who have been concerned with putting into practice the discoveries and inventions he has made. In common with many other truly great minds, it has been his choice to avoid publicity and public appearance, so that outside the circle of his immediate associates and a few of the more mathematically gifted students of his chosen branch of electrical science, his fame is far from commensurate with his achievements.

In Campbell's case, lack of participation in public activities must not be interpreted as indifference or lack of interest in the common welfare. He has shown himself in the highest sense to be an idealist, and having once aligned himself with a cause, he has served it devotedly without regard to the toll of effort it might exact from him personally. In recent years, he has enlisted in the struggle centered about the adoption of a rational system of physical units. He early became convinced of the fundamental soundness and simplicity of the set first advanced by Giorgi, and some of his latest papers (four are included in the present volume) deal with the merits of Giorgi's proposal.

We who have grown up under Campbell's inspiration and tutelage most deeply regret his retirement from active participa-

tion in the work of the organization to which he has rendered such conspicuous service. He has been more than a pioneer and inventor. His mode of life and work has been as much an inspiration as his technical contributions are foundation stones of the telephone art. His self-sacrifice and devotion will long linger in our memories, and his serenity sets a high goal toward which we, in our individual efforts, will aspire but seldom reach. Viewing his long and successful career, we realize anew the profundity of Emerson's declaration, " the great man is he who, in the midst of the crowd, keeps with perfect sweetness the independence of solitude."

E. H. Colpitts

Notes on Recent Occurrences

DR. C. J. DAVISSON OF BELL LABORATORIES SHARES NOBEL AWARD IN PHYSICS

ANNOUNCEMENT on November 11 that Dr. Clinton J. Davisson of the Bell Telephone Laboratories shares with Prof. George P. Thomson of London the 1937 Nobel Prize in Physics brings world-wide recognition to the researches of a scientist who has been a member of these Laboratories since their organization. The award to Dr. Davisson is for his demonstration that electrons, one of the fundamental building blocks of all forms of matter, and which familiarly display themselves as tiny particles of negative electricity, behave under certain conditions as trains of waves. An earlier discovery by A. H. Compton—also a Nobel prize recipient—showed that beams of light which usually display themselves as trains of waves, will under suitable circumstances act also as particles. The electron and the light quantum behave as though they had dual personalities.

The discoveries of Compton and of Davisson each furnish independent proof of a basis theory of modern physics: That matter (mass) and energy are again but dual aspects of a single entity. In experiments continuing over a number of years, Dr. Davisson, in association with Dr. L. H. Germer, also of the research staff of the Laboratories, directed beams of electrons against a target of a crystal of nickel, from which the electrons were diffracted in the form of trains of waves—a characteristic of energy.

In 1928 the National Academy of Sciences awarded the Comstock Prize to Dr. Davisson " for the most important discovery of or investigation in electricity or magnetism or radiant energy " made in this country during the past five years, for his

work in this field. In 1931 he and Dr. Germer received the Elliott Cresson medals from the Franklin Institute, Philadelphia, and in 1935 he received the Hughes Medal of the Royal Society of London.

The Nobel Prizes were instituted under the terms of the will of Alfred B. Nobel, Swedish chemist and engineer and the inventor of dynamite and other high explosives, who died in 1896. The income from a fund so established is divided annually among those persons who have contributed most to the advancement of Physics, Chemistry, Physiology or Medicine, Literature, and the Cause of Peace. The prize in physics is awarded by the Swedish Academy of Science in Stockholm. Distinguished Americans who have received the Nobel Prize in physics are A. A. Michelson, R. A. Millikan, and Arthur Compton.

MOTION PICTURES TRANSMITTED OVER COAXIAL SYSTEM SHOW CABLE'S POSSIBILITIES FOR TELEVISION

THE transmission of sound motion pictures over the coaxial cable between New York City and Philadelphia was demonstrated in the latter city before Bell System executives and newspaper men on November 9. The principal feature of the demonstration was the presentation of a sound motion picture, sent through the cable from the Bell Telephone Laboratories in New York, which, as it went along, described by voice and animated diagram how it was being transmitted and received. Several news-reel "shots," with sound, were also transmitted.

The motion pictures were reproduced in Philadelphia on a glass screen large enough for a group of ten people to see easily. The accompanying sound came from a loud speaker.

The experimental coaxial cable system between the two eastern cities has at present a million-cycle range. The Bell System, in anticipation of the time when it may be called on to transmit television programs to broadcasting points, just as it

now carries radio broadcasting programs on its wire and cable networks, wished to test the performance of the coaxial system in handling a single message whose frequency components occupy a range as broad as a million cycles; that is, a current of the kind required in television programs.

Sound motion pictures represent a convenient laboratory method of simulating the type of television program which may at some time in the future be offered for transmission. The Laboratories therefore constructed a transmitter to originate that wide range of frequencies, and a suitable television receiver. It was these which were employed in the transmission and reception of the program on November 9.

TELEPHONE SERVICE OPENED BETWEEN NEW YORK AND BAGDAD

TELEPHONE service direct from New York to Bagdad, the capital of 'Iraq, was inaugurated on December 15 with a conversation between Said Righed Rashid and Mr. Lowell Thomas, who was associated in Arabia during the World War with Emir Feisal, later the first King in Bagdad and the father of the present ruler. The telephone call went through the American Telephone and Telegraph Company's overseas switchboard, over a short-wave circuit to London, England, thence by short-wave to Cairo, Egypt; and on the banks of the Nile it changed from a short-wave circuit to a land line across the Suez Canal over the Sinai Desert, north through Palestine and on across the North Arabian Desert to old Bagdad.

RADIO TELEPHONE SERVICE TO S.S. WASHINGTON

RADIO telephone service between the S.S. Washington and shore stations of the American Telephone & Telegraph Company was opened December 15, 1937. The service, operated on board the liner by the Mackay Radio and Telegraph Company, will be available throughout the vessel's voyages

across the Atlantic, for connection to all Bell and Bell-connecting phones.

D. A. CRAWFORD AND ELIHU ROOT ELECTED DIRECTORS OF AMERICAN TELEPHONE AND TELEGRAPH COMPANY

AT a meeting of the Board of Directors of the American Telephone and Telegraph Company held on December 15, Elihu Root, Jr. of New York and David A. Crawford of Chicago, were elected to fill the vacancies caused by the deaths of E. E. Loomis and Thomas Nelson Perkins.

Mr. Root is a member of the legal firm of Root, Clark, Buckner and Ballantine, and Mr. Crawford is President of The Pullman Company.

VICE PRESIDENT JEWETT TO RECEIVE "WASHINGTON AWARD"

DR. FRANK B. JEWETT, Vice President of the American Telephone and Telegraph Company, has been named to receive the "Washington Award" for 1938.

This honor is granted annually by a committee representing the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Western Society of Engineers.

The award was instituted in 1916 by Dr. John Watson Alvord, a Past-President of the Western Society of Engineers and a distinguished consulting engineer of Chicago, whose letter to the governing body of that Society included the following: "Being desirous of promoting a better appreciation by the public of able work accomplished by engineers for the public welfare . . . I desire to see established an honor award,—by medal or other tribute—to be annually presented to that engineer whose particular work in some special instance or whose

services in general have been noteworthy for their merit in promoting the public good." The award is made by a Committee composed of nine representatives of the Western Society of Engineers and two each from the four other engineering bodies mentioned above.

Former recipients of the Washington Award have been: Herbert Hoover, 1919; Captain Robert W. Hunt, 1922; Prof. Arthur Newell Talbot, 1923; Jonas Waldo Smith, 1925; John Watson Alvord, 1926; Orville Wright, 1927; Dr. Michael I. Pupin, 1928; Bion J. Arnold, 1929; Dr. Mortimer E. Cooley, 1930; Ralph Modjeski, 1931; William D. Coolidge, 1932; Ambrose Swasey, 1935; Charles Franklin Kettering, 1936; and Frederick G. Cottrell, 1937.

RECORD-BREAKING HOLIDAY LONG DISTANCE AND OVERSEAS TRAFFIC

THE volume of long distance and overseas telephone traffic reached a new high on Christmas Day, even breaking through levels of 1929 and before. Long distance calls put through at fourteen representative points rose almost six per cent over the high figures of last year while there were 755 Yuletide overseas messages, or eleven per cent more than in 1936.

The longest Christmas greeting traveled through telephone lines and the ether some 11,000 miles, as it sped from Johannesburg, South Africa, to Chicago. Paris and New York were involved in the conversation of longest duration—a Christmas Day message lasting thirty-one minutes. Among the calls which linked distant places was one set up between Greenwich, Conn., and Calcutta, India.

Transpacific overseas telephone calls established from the operating center of the American Telephone and Telegraph Company at San Francisco increased by about thirty-four per cent over last year. Japan was among the countries where

traffic volume showed a marked rise, the number of seasonal calls placed being almost three times that tallied in 1936. Similarly, large increases were registered in several European countries—holiday calls established with Italy rising some 300 per cent and those to France and Germany increasing by one-quarter and one-seventh, respectively. In addition, a number of holiday greetings were telephoned from ships in mid-Atlantic.

Thousands of telephone employees worked on Christmas to rush the flow of long distance traffic over land lines in the United States. Thanks to carefully worked out preliminary arrangements, and to the use of such new facilities as the fourth transcontinental route to the Pacific coast, delays on long haul long distance service incident to heavy demand were of shorter duration than in previous years. Memphis, Tenn., and Minneapolis, Minn., showed the highest increase in the use of long distance service.

The program transmission facilities of the American Telephone and Telegraph Company assisted in bringing four Christmas radio programs from abroad. Late on Christmas Eve carols, sung by a choir in Bethlehem in Palestine and then routed to London via Cairo, Egypt, were dispatched across the Atlantic on American Telephone and Telegraph Company channels, for use on a network of the National Broadcasting Company.